NMB 8080.1
(FORMERLY NPC 500-10)

OFFICE OF MANNED SPACE FLIGHT

APOLLO PROGRAM

APOLLO

TEST REQUIREMENTS

(REPRINT OF NPC 500-10 THROUGH CHANGE VI)

MARCH 1967

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546

FOREWORD

May 20, 1964

This document is an official release of the Apollo Program Office and its requirements shall be implemented by all cognizant elements of the Apollo Program.

It is recognized that in implementing these requirements, their impact on the on-going program must be assessed. It is expected that the bulk of these requirements can and will be implemented at once. However, there undoubtedly will be aspects of the test program that should be permitted to deviate from these requirements in order to minimize adverse effects on schedule or costs. Such areas should be identified expeditiously and reported to the MSF Apollo Program Office in accordance with the procedures stated in Appendix A of this document. Justification of, or basis for deviation should be included.

SAMUEL C. PHILLIPS
Major General, USAF
Director, Apollo Program

(REPRINT OF NPC 500-10 THROUGH CHANGE VI)

MARCH 1967

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SECTION 1: INTRODUCTION

1.1 PURPOSE

The Apollo Test Requirements provides test policy, establishes minimum test requirements, and test documentation requirements which are to be met by the National Aeronautics and Space Administration (NASA) Centers having Apollo responsibilities.

1.2 SCOPE AND APPLICABILITY

The ATR is applicable to all ground and flight tests of space vehicle hardware and associated active ground support equipment (GSE). It is applicable to the following program elements:

a. Apollo Spacecraft
b. Little Joe II
c. Saturn I (Flight Test Only)
d. Saturn IB
e. Saturn V
f. Apollo Support Hardware

Detailed test and documentation requirements shall be established by the Centers to comply with the requirements specified herein. The requirements specified in this document shall be fully reflected in subsidiary Apollo test documents and related contractor scopes of work.

1.3 APPLICABLE DOCUMENTS

The following documents form a part of the ATR to the extent specified herein:

NASA Quality Publication NPC 200-1	Quality Assurance Provisions for Inspection Agencies
NASA Quality Publication NPC 200-2	Quality Program Provisions for Space Systems Contractors
NASA Quality Publication NPC 200-3	Inspection System Provisions for Suppliers of Space Materials, Parts, Components and Services.

NASA Reliability Publication NPC 250-1	Reliability Program Provisions for Space System Contractors
SE005-001-1	Apollo Program Specification
SE010-000-1	Apollo Flight Mission Assignments
SE015-001-1	Natural Environment and Physical Standards for the Apollo Program
NASA SP-6001	Apollo Terminology
_____	Apollo Human Standard Specification (in preparation)
NPC 500-1	Apollo Configuration Management Manual

In the event of any inconsistency of test requirements between the ATR and applicable documents, the ATR shall take precedence. In the area of specifications required by NASA Apollo Configuration Management Manual, NPC 500-1, test requirements are to be included in Section 4 of these specifications in detail or by reference to appropriate test documents by Title, Number, Date and Revision Letter.

1.4 CHANGES, REVISIONS, AND DEVIATION APPROVAL

1.4.1 Changes. Request for changes to the ATR shall be processed in accordance with the approval procedure in Appendix A.

1.4.2 Revisions. Revisions of the ATR will be published by MSF when deemed appropriate.

1.4.3 Deviation Approval. Whenever a Center determines that some element of their test program should be conducted in a manner inconsistent with the ATR, a request for deviation approval shall be processed in accordance with the approval procedure given in Appendix A.

An exception to this requirement for deviation approval is specified in paragraph 3.3.6.2 and relates to the shipment of hardware from the manufacturing site without completion of the requirements for Certification of Flight Worthiness (COFW).

1.5 DEFINITIONS

Definitions of terms used in this document are contained in Appendix B. Wherever possible, definitions are in agreement with those given in the NASA SP-6001, Apollo Terminology.

1.6 ABBREVIATIONS

Certain abbreviations and codes which have gained acceptance in the Apollo Program have been used in this document. For convenient reference, they are collected in Appendix C.

SECTION 2: TEST POLICY

2.1 GENERAL

2.1.1 Test - A Key Factor. The Apollo test program is a key factor in assuring the successful accomplishment of the Apollo mission.

2.1.2 Test Guidelines. This section presents the guidelines to be used in the test program for which minimum requirements are established in sections 3, 4, 5, and 6. These guidelines will be utilized in the development of any additional requirements.

2.2 GENERAL TEST POLICY

2.2.1 Test Purpose. The overall test program will be designed to yield the maximum amount of correlated data for use in establishing the highest possible degree of engineering confidence in the performance of space vehicle and associated ground equipment.

2.2.2 Engineering Judgment. Since limited funds and accelerated schedules will not generally allow performance tests on a large number of specimens, it is mandatory that the best engineering judgment be applied in the design of tests and analysis of the results.

2.2.3 Duplication. Cognizance will be taken of data from previous testing. Previous tests will not, in general, be duplicated and testing will cover primarily areas of new and/or increased test requirements.

2.2.4 Environment. Tests will be conducted to the maximum extent practicable under mission environments.

2.2.5 Number of Test Specimens. Assemblies and other lower levels of hardware that are vital to the life of the crew will be tested in sufficient number to yield a significant level of engineering confidence. Also, the state-of-the-art or uncertainty associated with certain hardware will require larger numbers of test specimens and more extensive testing in depth.

2.2.6 Reliability Assessment. Data from all types of tests are expected to be used for reliability assessment.

2.2.7 Test Anomalies. Anomalies which occur during testing shall be resolved before proceeding with scheduled tests. This does not preclude the conduct of specific tests aimed at resolving the anomaly.

2.2.8 Center Review and Control. All tests on systems, subsystems, major assemblies and components, and special items designated by the Centers shall be performed, supervised, monitored or reviewed by cognizant Center personnel or their designated representative.

2.2.9 Control of Contractor. Contractor test activities shall be controlled by the cognizant Center with direct monitoring or review to the extent deemed necessary by the Center. The Center shall establish contractually the prerogative to select (on a random or planned basis) hardware produced by the Contractor and subject it to independent verification and inspection tests.

2.3 TEST TYPES

The tests performed in the Apollo program shall be categorized by the basic types presented below. Although there is no intention to preclude the use of other terminology, the test types listed shall be adopted as the standard terminology for planning, communication between Centers, and between Centers and MSF. Definitions of these test types appear in Appendix B. When other test type terminology is used, it shall be grouped under or identified by the basic test types below:

2.3.1 Test Type Categories.

Ground Tests

a. Development Tests (Engineering Test and Evaluation)

- Component and Subsystem
- Battleship
- Structural
- Dynamic
- Systems Compatibility
- All-Systems

b. Acceptance Tests

- Receiving Tests
- In-process Tests
- Manufacturing Checkout
- Static Firing Test
- Post-Static Firing Checkout

Pre-Use Checkout of GSE

Checkout at Installation Site
Systems Compatibility Check

c. Checkout of GSE

Pre-Use checkout prior to launch
Final verification tests during flights

d. Pre-Launch Checkout

e. Qualification Tests

Component and Subsystem
Structural
Dynamic
Systems Compatibility
All-Systems

f. Reliability Demonstration Tests

g. Post-Flight Tests

Flight Tests (Unmanned and Manned)

a. Flight Development Test

b. Flight Verification Test

2.3.2 Test Type Relationships. Figures 2-1 and 2-2 show typical test type relationships which exist for flight hardware and ground support equipment respectively. These figures illustrate the relation between the various tests specified in paragraph 2.3.1 and the flow of hardware. Since the requirements for certain test types may depend on the criticality rating and the type of hardware, these figures do not illustrate the complete set of relations. Specific requirements on any piece of hardware are shown in tables 3-3 and 3-4.

2.4 GROUND TEST POLICY

2.4.1 Ground Test Purpose. Ground tests shall be utilized to minimize the number and cost of development flight tests required to produce reliable operational systems.

2.4.2 Levels of Hardware. Tests shall be planned for the various generation levels of hardware. Particular emphasis shall be given to interactions at higher levels which are not seen at lower levels.

2.4.3 Hardware Failure. Any failure of a test specimen under specified operating conditions during a ground qualification test shall disqualify the entire class of hardware (all items of hardware made to the same specifications as the qualification test hardware). The extent of the retesting shall be determined by the Centers.

2.4.4 Hardware Usage. Hardware used for ground qualification test shall be used for reliability demonstration test where feasible, but hardware used for qualification test or reliability demonstration test shall not be used for flight vehicles.

2.4.5 Certification for Flight. Hardware types must complete ground qualification tests and all hardware must receive a Certification of Flight Worthiness before flight test.

2.4.6 Man-Machine Compatibility. Particular emphasis shall be given to qualifying the man-machine compatibility.

2.5 FLIGHT TEST POLICY

2.5.1 Flight Test Purpose. Flight testing shall be employed to the extent necessary to insure crew safety and to provide a sufficient level of assurance of mission success.

2.5.2 All-Up Testing. All-Up testing will be the basic approach to the flight verification test program. It requires that where practicable, all flights will be scheduled as complete space vehicles using all live stages and as much of the lunar mission flight hardware as can be made available.

2.5.3 Mission Objectives. The number and types of mission objectives assigned to an individual flight shall be chosen to yield the maximum amount of useful engineering data and flight verification test time consistent with safe flight.

2.5.4 Deletion of Excess Testing. While the number of space vehicles and tests planned will be adequate to assure that program goals can be met, continuous program review shall be made to delete or re-assign any hardware or tests that become excess to this program as a result of early successes.

2.5.5 Prerequisite to Manned Flight. Flight verification of hardware failure of which would result in loss of crew, is required as a prerequisite to manned flight.

2.5.6 Space Vehicle Capabilities. To provide adequate back-up flight mission capability, each space vehicle shall be capable of handling the mission assigned to the preceding space vehicle of its class (class refers to Saturn IB or Saturn V class missions). The only exception is in the area of extensive instrumentation required for the spacecraft heat shield and early vehicle R&D flights where such instrumentation is not required for all vehicles.

2.5.7 Orbital Refuse. Orbital refuse shall be minimized.

FIGURE 2-1

TEST TYPE RELAT IONSHIPS FOR SPACE VEHICLE HARDWARE

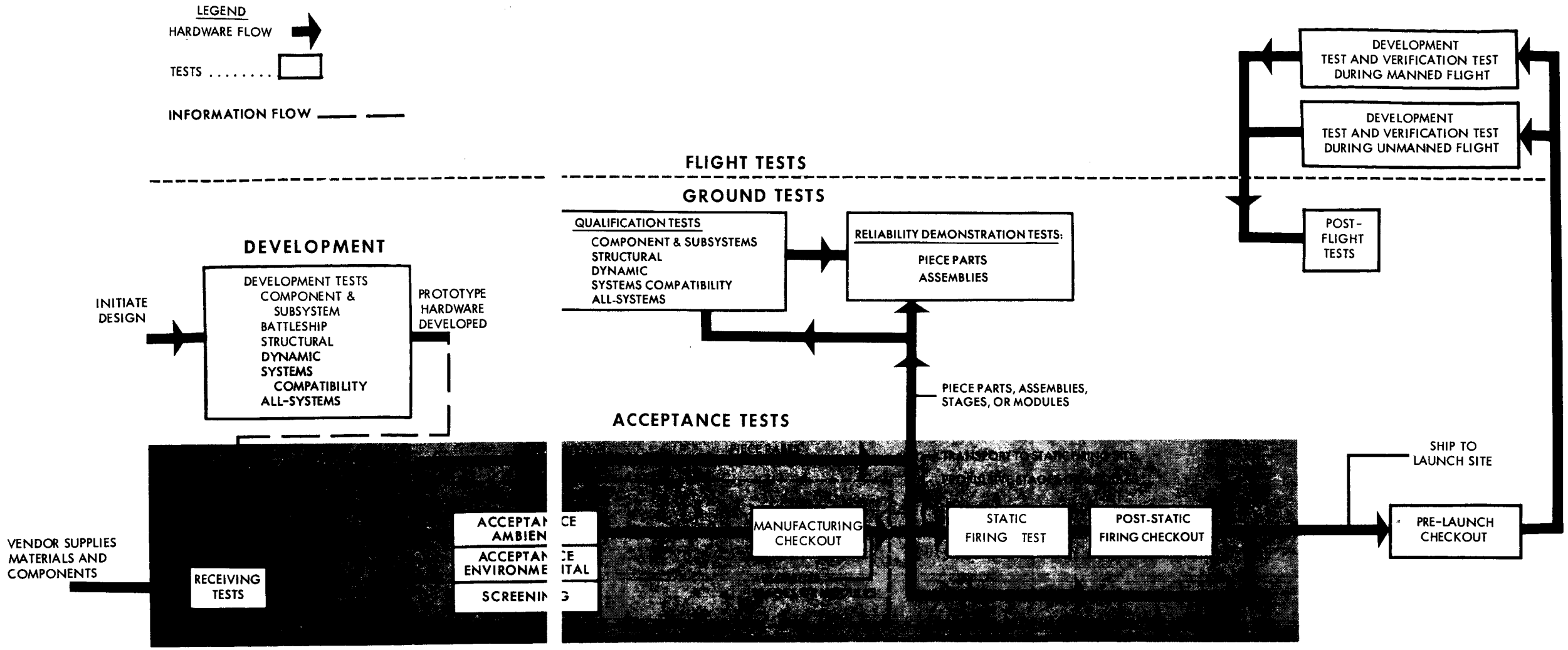


FIGURE 2-2

TEST TYPE RELA ATIONSHIPS FOR GROUND SUPPORT EQUIPMENT

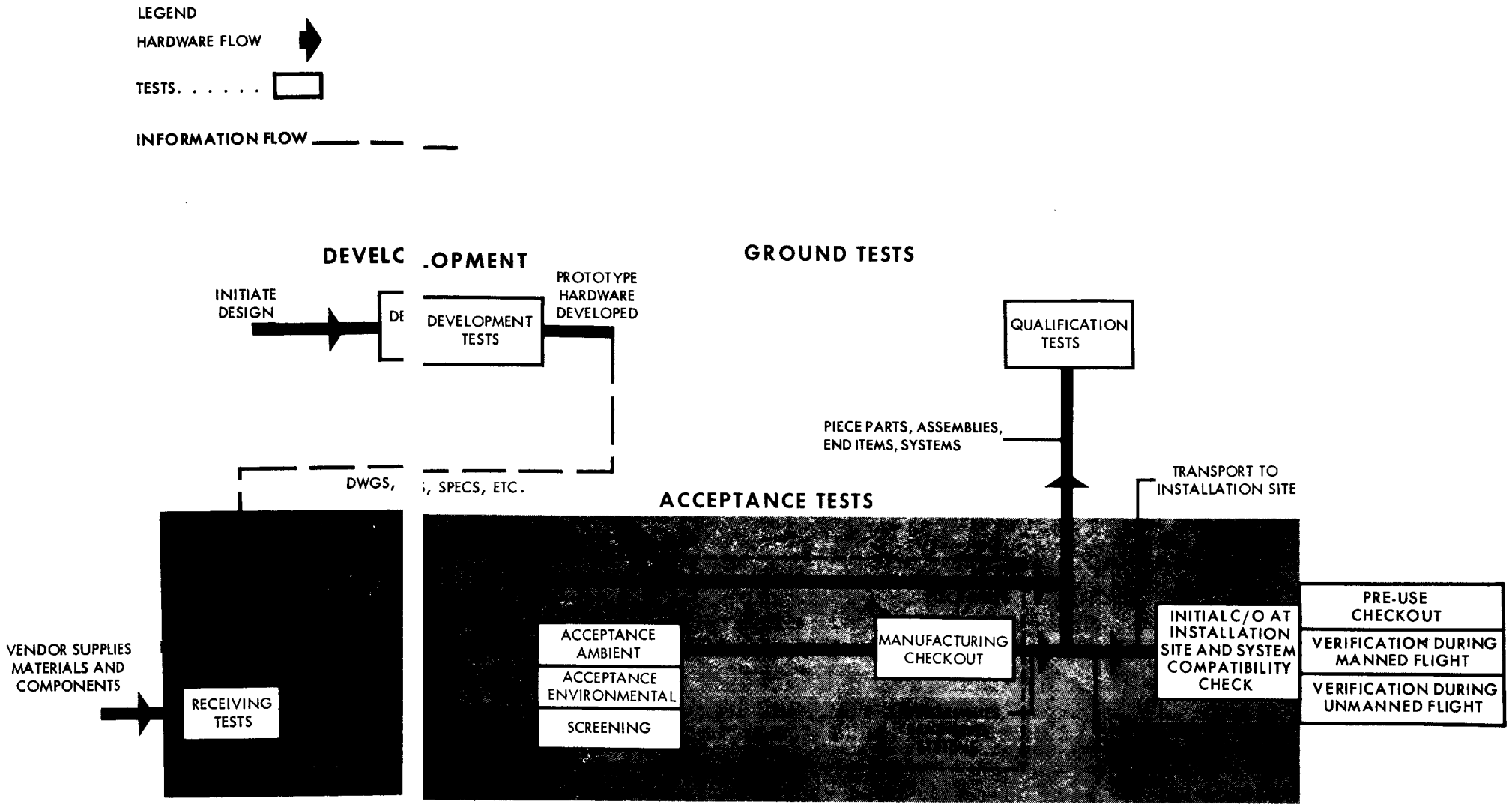


TABLE 3-1

HARDWARE CRITICALITY CATEGORIES FOR FLIGHT HARDWARE

Category 1 - Hardware, failure of which results in loss of life of any crew member. This includes normally passive systems i.e., Emergency Detection System, Launch Escape System, etc.

Category 2 - Hardware, failure of which results in abort of mission but does not cause loss of life.

Category 3 - Hardware, failure of which will not result in abort of mission nor cause loss of life.

TABLE 3-2

HARDWARE CRITICALITY FOR GROUND GROUND SUPPORT EQUIPMENT (GSE)

Category A - Hardware, failure of which results in the loss of life of any crew member or ground crew member.

Category B - Hardware, failure of which results in abort of mission but does not cause loss of life.

Category C - Hardware, failure of which will not result in abort of mission nor cause loss of life.

SECTION 3: GROUND TEST REQUIREMENTS

3.1 PURPOSE AND INTENT

Ground tests shall be utilized to the maximum extent to minimize the number and cost of development flight tests required to produce operationally suitable space vehicles and their associated ground support equipment (GSE). The high cost, effort, instrumentation restraints and difficulties associated with flight tests require that the less costly ground tests be utilized wherever possible to validate the performance of Apollo hardware.

3.2 OBJECTIVES

The prime objectives of ground tests are:

a. Evaluation of new materials, processes, piece parts, components, assemblies, and subsystems in support of Apollo program development efforts.

b. Verification that hardware fulfills design and quality requirements prior to delivery of flight hardware from the contractor's plant.

c. Evaluation and qualification of the man-machine relationship.

d. Establishment of confidence that hardware will perform adequately during flight and furnish data for reliability assessment.

e. Minimization of number of flight tests required.

f. Minimization of time and cost of reaching operational status.

g. Verification and establishment of launch operating techniques and procedures.

h. Verification of the compatibility between the stage/vehicle and GSE.

3.3 GENERAL REQUIREMENTS

3.3.1 Ground Test Planning. Ground test planning shall emphasize testing at the higher generation levels of assembly. Particular emphasis shall be given to interactions at higher levels which may not occur at lower levels.

3.3.2 Environmental Conditions. Tests shall be conducted to the maximum extent practicable under mission environments, including anticipated combinations and sequences of stresses. Consideration shall be given to both natural and induced environments. Selection of natural environments shall be in accordance with the Apollo Program Specification, SE005-001-1, and the Natural Environment and Physical Standards for the Apollo Program, SE010-001-1. When planning tests, emphasis shall be given to simulating the most adverse environments for the specific hardware including those environments encountered during transportation, handling, assembly, etc.; e.g., qualification tests of solid motors and other ordnance items should include induced electrostatic charges which may be encountered during handling operations prior to launch. The Centers shall be responsitle for determining the levels of environment and the operating time or cycles in accordance with test policy and test requirements specified in this document.

3.3.3 Criticality Categories. The Centers shall develop a failure effects analysis system which will be utilized to establish the criticality categories of hardware in accordance with tables 3-1 and 3-2. A listing of the criticality categories of all hardware for each stage, module, and GSE shall appear in the appropriate test plans for the stages, modules and GSE (Paragraph 6.2.4.5). This listing shall be updated as required and shall be made readily available for test planning activities throughout NASA.

3.3.4 Test Emphasis. The Centers shall develop a priority listing of all hardware for each stage, module, and GSE. This listing shall appear in the test plans for the appropriate stage, module, and GSE (Paragraph 6.2.4.5). Test emphasis shall be based on a priority rating. Factors which affect the test priority are:

Criticality category of the hardware.
Presence of new technology.
Design safety factors.
Test types.

3.3.5 Minimization of Test Duplication. Special effort shall be made to avoid duplications of previous tests from this or other similar programs. Items which have been qualified for an equivalent application shall be carefully reviewed by the Center for acceptance as a qualified item. If the previous application is considered by the Center to be similar, but not equal or more severe, the test plan should concentrate on testing in the areas of new or increased requirements. Similarity of design, fabrication and inspection procedures shall be considered. The applicable history and methods of prior tests shall be suitably referenced or incorporated into test plans.

3.3.6 Certification of Flight Worthiness (COFW)

3.3.6.1 Procedures for COFW.

The MSFC and the MSC shall establish procedures for Certification of Flight Worthiness of each flight stage and module (includes IU and spacesuit). Each Program Manager shall appoint an individual responsible for the preparation of the COFW and whose signature is necessary to the completion of the certificate prior to shipment of hardware from the manufacturing site. The COFW shall specify as a minimum the following:

a. Acceptance tests through manufacturing checkout, qualification tests, and reliability demonstration tests have been successfully completed and meet the requirements of Sections 3.6, 3.7, and 3,8. Failures of flight hardware in criticality categories 1 and 2 have been analyzed and corrective action implemented in accordance with Section 3.7, NASA Reliability Publication NPC 250-1.

b. The spacecraft, vehicle, system, subsystem, assembly and component specifications and drawings were developed in accordance with the Apollo Configuration Management Manual, NPC 500-1, and Section 3, NASA Reliability Publication, NPC 250-1 and Section 4.2, NASA Quality Publication 200-2. Each departure therefrom has been approved by the Material Review Board in accordance with Section 8.1, NASA Quality Publication, NPC 200-2.

c. The hardware has been manufactured, inspected, and tested in accordance with the approved quality control program, Section 7.3, 7.4, 12, 14.2 of NASA Quality Publication NPC 200-2.

d. The item of hardware is complete and in accordance with Section 14.2.4 of NASA Quality Publication NPC 200-2.

e. All data packages and support manuals necessary for operation and checkout of the item are complete, compatible, and accompany the hardware, and that shipping requirements of Section 11.6 of NASA Quality Publication, NPC 200-2 have been met.

3.3.6.2 Deviation Procedure. In the event that the requirements of paragraph 3.3.6.1 above cannot be fulfilled on schedule, the authorized Center representative shall request direction from the Center Program Manager pertaining to whether:

a. Schedules shall be delayed for completion of these requirements, or

b. The item will be shipped without fulfilling all requirements. In this case, the COFW shall certify the hardware to the extent possible and identify all exceptions and follow-on actions required.

In either case, the Center Program Manager will, after suitable coordination, confer with the Director, Apollo Program, Code MA, to reach agreement as to the disposition of the hardware. In cases where shipment of the hardware is involved, the final decision agreed upon will be documented and used in lieu of the deviation approval procedure specified in Appendix A.

3.3.6.3 COFW to Accompany Hardware. The COFW will accompany the hardware to the launch site. After satisfactory completion of post-static firing checkout, the responsible Center representative at each site shall add an endorsement to the COFW which identifies any discrepancies or deficiencies uncovered during inspection and checkout, and the corrective action taken. Copies of each COFW and each endorsement shall be forwarded to Director, Apollo Test, Code MAT, and the appropriate launch site personnel.

3.3.7 Spares Plan

Centers responsible for hardware shall prepare a spares plan providing for:

a. Establishment of spares requirements to support ground test and checkout operations.

b. Contractual provisions for the manufacturing and acceptance testing of spares in quantities sufficient to accomplish each test program on schedule. (Spares to be subjected to the same tests and to be functionally and physically interchangeable with the replaced item.)

c. Assurance of the availability, preservation and accountability of the spares, establishment of logs for each spare unit to record its test data and accumulated operating time or cycles, and instructions for the disposition of the replaced defective hardware.

3.3.8 Facilities and Test Equipment.

3.3.8.1 Identification. Each Center shall be responsible for identifying, within its test plans, the major test facilities and special test equipment required. Below the stage or module level, facilities and equipment may be summarized on the basis of hardware generation levels and test types. The facilities and test equipment shall be presented in the following categories:

a. Existing (owned, leased, or to be acquired):

1. Contractor
2. NASA
3. Other government agency

b. Future (to be built or extensively modified):

1. Contractor
2. NASA
3. Other government agency

3.3.8.2 Test Facility Activation Plans. Each Center shall be responsible for the establishment of test facility activatio plans covering on-site assembly, installation, integration, checkout and calibration of test equipment at industrial and government sites where Apollo hardware is fabricated and/or tested. These plans also involve facilities, people, and procedures. They need not be separate documents but may be part of more comprehensive documents.

3.3.8.3 Test Equipment Qualification. Test equipment used in the conduct of all ground tests except development tests must be qualified, regulated, and certified to insure known inputs to the hardware being tested and to insure that the test equipment will not cause damage and/or introduce contaminants to the hardware being tested.

3.3.8.4 Calibration and Maintenance. The calibration, maintenance, and control of test equipment shall be in accordance with Section 9 of NASA Quality Publication, NPC 200-2.

3.4 DEVELOPMENT TESTS

3.4.1 Objectives. Development tests are performed to assure the proper functioning of the components of the system. Specific test objectives include: determination of feasibility of design approach, evaluation of hardware performance under simulated or actual environmental conditions, and evaluation of hardware failure modes and safety factors.

3.4.2 Requirements. Development test requirements are as follows:

a. The Centers shall be responsible for determining what development tests are required. Development tests shall include as a minimum the specific ground tests specified in paragraph 3.5 below.

b. Tests shall be performed on developmental hardware which is representative of (but not necessarily identical to) the flight hardware and the operational GSE.

c. The Centers shall determine when the design has progressed to the degree that ground qualification tests may commence.

d. The Contractor development test programs shall include the Design and Development Control requirements specified in Section 4.2, NASA Quality Publication NPC 200-2.

3.5 SPECIFIC GROUND TESTS

3.5.1 General. The paragraphs which follow define certain specific ground tests which must be performed on all stages and modules in accordance with table 3-3.

3.5.2 Dynamic Tests.

3.5.2.1 Objectives. The objectives of dynamic tests are to:

a. Determine the structural dynamic characteristics under conditions simulating flight dynamics insofar as practicable.

b. Qualify the hardware to perform within the characteristics determined in 3.5.2.1a above.

c. Determine physical mating compatibility of stages and modules.

d. Compare dynamic test results with subsequent flight test results for continuous development of dynamic test techniques and facilities to assure the highest possible degree of accuracy in the development and qualification of the vehicle structure prior to flight.

3.5.2.2 Requirements. Dynamic tests shall be performed to fulfill the above objectives on stages and modules and combinations of stages and modules representative of the flight configuration. When design changes are made, which, by a determination of the Centers, significantly affect dynamic characteristics, a dynamic test shall be performed on the modified configuration. MSFC shall be responsible for the performance of the dynamic tests for the space vehicle and various combinations of spacecraft and launch vehicle. The performance of the remaining dynamic tests shall be the responsibility of the cognizant NASA Center. Dynamic tests may be a combination of development tests and ground qualification tests.

3.5.3 Systems Compatibility Tests.

3.5.3.1 Objectives. The objectives of systems compatibility tests are to determine the physical, functional and operational compatibility of stages, stage and IU, launch vehicle and spacecraft, modules, spacecraft and LES, space vehicle and ground support equipment, and systems within the ground support equipment.

5.5.3.2 Requirements.

a. As a minimum, systems compatibility tests shall provide reasonable assurance that:

(1) Stages, modules, launch vehicle and spacecraft (for the specific configuration to be flown) are physically, functionally and operationally compatible (including electromagnetic compatibility) prior to shipment of the first flight stages and modules to the test site.

(2) Stages, modules, or space vehicle are compatible with ground support equipment (including checkout and calibration equipment) at a manufacturing plant, static firing test area, and the launch area prior to shipment of the first flight hardware (for the specific configuration to be flown) to the above areas.

b. The Centers shall be responsible for establishing the detailed test plans and conducting the tests on interface hardware under their control. System compatibility tests may be a combination of development test and ground qualification test.

3.5.4 Structural Tests

3.5.4.1 Objective. The objective of structural tests is to determine the ability of structures to withstand predicted or measured static and dynamic forces which may be encountered in assembly, storage, transportation, handling, testing, and flight.

3.5.4.2 Requirements.

a. Each Center shall establish and implement structural tests for flight hardware within its area of responsibility.

b. Structural tests shall be performed on the largest practicable assemblies of structural hardware for all stages and modules. As a prerequisite, tests of structural details and component structures should have been completed and evaluated.

c. The following shall be considered in the development of structural test plans:

(1) The determination of effects of aerodynamics, cryogenics, winds, thrust, vibration, and static forces, etc.

(2) The determination of effects of multiple environments on the structure.

(3) The determination of safety factors, failure characteristics, and design limitations by the proper sequencing and application of overstress.

(4) The completion of portions of the structural tests that are related to specific events prior to the performance of the events such as transportation, static test firing, etc.

d. Structural tests at the generation level specified in paragraph 3.5.4.2b above may be a combination of development test and ground qualification test.

3.5.5 All-Systems Tests.

3.5.5.1 Objectives. The objectives of an all-systems test are to demonstrate:

a. The capability of each subsystem within stages and modules to perform its function when exposed to the simulated rigors of flight mission environment.

b. That the subsystems within stages and modules are physically and functionally compatible.

c. The functional compatibility between stage and module subsystems and the ground support equipment.

3.5.5.2 Requirements. The Centers shall be responsible for the performance of the all-systems test to fulfill the objectives in paragraph 3.5.5.1 above. The minimum test requirements are:

a. Use of a complete stage or module representative of flight hardware.

b. Use of GSE representative of equipment to be used at the launch site.

c. Retest when significant hardware changes are made which invalidate results of previous tests.

All-systems tests may be a combination of development test and ground qualification test.

3.6 GROUND QUALIFICATION TESTS

3.6.1 Objective. The Ground Qualification Program test objective is to verify that the space vehicles and associated ground support equipment meet design specification requirements necessary to assure operational suitability at anticipated environments for their use cycles.

3.6.2 Requirements. Minimum ground qualification test requirements are as follows:

a. Ground qualification tests and specific ground tests (paragraph 3.5) shall be performed on a sample of flight type production hardware in accordance with table 3-3.

b. All tests specified in table 3-4 shall be successfully completed on a sample of production equipment. Such successful completion shall comprise the qualification of the ground support equipment.

c. The Centers shall be responsible for the determination of the number of units (sample size) for each class of hardware to be tested.

d. Certain special tests such as burst tests to verify that hardware does not fail below proof limits shall be performed as required to assure operational safety.

3.6.2.1 Prerequisites.

a. Acceptance tests through manufacturing checkout shall be performed on hardware prior to its being subjected to ground qualification tests. Up to the specific generation level to which the qualification tests apply, the acceptance tests shall be identical to the acceptance tests performed on flight hardware or operational GSE including the vigorous inspection imposed thereon.

b. In addition to production test time, additional functional test time shall be accumulated on the test specimen which is representative of that portion of the functional life cycle to be encountered prior to mission use.

3.6.2.2 Test Specimen Control. Qualification tests shall be performed on production hardware under strict control of environments and procedures. Revisions to procedures, adjustments, or tuning is not permissible during the course of a test unless it is normal to the in-service operation. If such action becomes necessary, the test specimen shall be disqualified pending corrective action. Hardware that has been subjected to ground qualification tests shall not be utilized on flight vehicles. It may, however, be utilized for reliability demonstration tests. The qualification test report shall state the disposition of the qualification units.

3.6.2.3 Simulated Environment. Simulated environments shall be determined by the Centers in accordance with paragraph 3.3.2 above.

3.6.2.4 Man-machine Relationships. Particular emphasis shall be given to qualifying the man-machine compatibility and the adequacy of the man-machine combination to fulfill the mission requirements.

3.6.2.5 Failure Disqualifies Entire Class of Hardware. Any failure of a test specimen shall disqualify the entire class of hardware (all items of hardware made to the same specifications and intended for the same application as the qualification hardware). Where a failure occurs, hardware or procedural changes shall be introduced into all test hardware and the qualification test shall be reinitiated. Center approval is a prerequisite to initiation of requalification testing. However, if the cause of failure is a quality defect which can be detected by a nondestructive inspection, then those units of the sample which have already been tested without failure need not be retested. Nevertheless, all units must perform without failure, including the retested units for which defects have been corrected. In the above cases, extreme caution shall be taken to assure that these changes and corrections are made to all units in the class and that such action will not degrade the units.

3.6.2.6 Requalification Tests. Hardware shall be subjected to requalification tests:

a. When design or manufacturing process changes have been made which affect functioning or reliability.

b. Where inspection, test, or other data indicate that a more severe environment or operating condition exists than that to which the equipment was originally tested.

c. When the manufacturing source is changed.

Center approval of the requalification test is required prior to initiation of testing.

3.7 RELIABILITY DEMONSTRATION TESTS

3.7.1 Objective. The principal objective of reliability demonstration tests is to establish a singificant level of engineering confidence in the reliability of the hardware.

3.7.2 Requirements

3.7.2.1 Test Levels. Reliability demonstration tests shall be performed on flight type hardware in accordance with table 3-3. These tests shall be a continuation of qualification tests to verify the life expectancy with the addition of overstress tests as necessary to determine failure modes and safety margins.

3.7.2.2 Prerequisite. A class of hardware shall be qualified in accordance with paragraph 3.6 above prior to its being subjected to reliability demonstration tests.

3.7.2.3 Test Hardware and Procedures

a. Reliability demonstration tests shall be performed on production hardware under the strictest control of environments and procedures. Units used for reliability testing shall be picked at random from the normal production run. Modification of procedures, adjustments, or tuning is not permissible during the course of the test unless it is normal to the in-service operation. If such action becomes necessary, the hardware shall, by definition, have failed.

b. Failure does not necessarily disqualify the hardware from further reliability demonstration testing. When repairs, adjustment, etc., have been made, the hardware shall be resubjected to acceptance tests prior to further reliability demonstration testing. Hardware under paragraph 3.6 above should be used for reliability demonstration testing where feasible.

c. Where test-to-failure is planned, prime emphasis shall be placed on time and/or cycles. The elevating of environmental stresses beyond those predicted or measured should be kept to a minimum consistent with the uncertainty of the environment to be encountered in use.

d. Hardware used in reliability demonstration testing shall not be used on flight vehicles.

3.8 ACCEPTANCE TESTS

3.8.1 Objectives. Acceptance tests are conducted on all hardware to determine conformance to design or specifications as a basis for acceptance. They may apply to parts, equipments or systems.

3.8.2 Requirements.

3.8.2.1 Acceptance tests shall meet the paragraph 3.8.1 objectives and be conducted in accordance with paragraphs 3.8.3 through 3.9.2a.

3.8.2.2 Acceptance tests shall be performed under the surveillance of the Centers or their authorized representatives. (This document does not purport to include all quality provisions; for details see NASA Quality Publication NPC 200-1, 200-2, and 200-3).

3.8.3 Receiving Tests

3.8.3.1 Objectives. Receiving tests are nondestructive, functional tests performed for the purpose of acceptance on piece parts, components, or assemblies on receipt by a manufacturer or a using agency.

3.8.3.2 Requirements

a. These tests shall be performed on 100 per cent of the functional (operating) items in accordance with tables 3-3 and 3-4.

b. A receiving test run under other than ambient conditions may also be considered an acceptance environmental test (see paragraph 3.8.7).

3.8.4 In-Process Tests

3.8.4.1 Objectives. In-process tests are production tests conducted for the purpose of acceptance and include all tests performed at intermediate points between receiving tests and start of final manufacturing checkout. Principal tests in this category are screening tests, ambient tests, and environmental tests (paragraphs 3.8.5, 3.8.6, and 3.8.7).

3.8.4.2 Requirements.

a. As a minimum requirement, in-process tests shall meet the paragraph 3.8.4.1 objectives and be performed at points of assembly where further assembly will reduce the capability of a complete functional test of the specific unit (see tables 3-3 and 3-4).

b. Additional requirements are contained in subsequent paragraphs 3.8.5, 3.8.6, and 3.8.7.

3.8.5 Screening Tests

3.8.5.1 Objectives. Screening tests are production tests conducted for the purpose of acceptance and are tests employing nondestructive environmental, electrical, or mechanical stresses to identify anomalous items.

3.8.5.2 Requirements. The Centers shall establish detailed screening test requirements meeting paragraph 3.8.5.1 objectives and in accordance with the provisions of tables 3-3 and 3-4.

3.8.6 Ambient Tests

3.8.6.1 Objectives. Ambient tests are production tests conducted for the purpose of acceptance under ambient environmental conditions such as pressure, temperature, etc., normal for the test location.

3.8.6.2 Requirements. The Centers shall establish the detailed ambient test requirements meeting paragraph 3.8.6.1 objectives and in accordance with tables 3-3 and 3-4.

3.8.7 Environmental Tests

3.8.7.1 Objectives. Environmental tests are production tests conducted for the purpose of acceptance under environmental rigors other than ambient for the prime purpose of verifying the quality of the flight hardware or ground equipment.

3.8.7.2 Requirements

a. The Centers shall establish the detailed acceptance environmental test requirements meeting paragraph 3.8.7.1 objectives and in accordance with the provisions of tables 3-3 and 3-4. For environmental conditions, see paragraph 3.3.2.

b. Environmental test levels may be lower than mission environments, provided the Centers determine that such a lower level will reveal all critical quality defects.

3.8.8 Manufacturing Checkout Tests

3.8.8.1 Objectives. Manufacturing checkout tests are tests performed for the purpose of acceptance after final assembly at a manufacturer's plant to assure as a minimum that hardware:

a. Was manufactured in accordance with design documents, drawings, and specifications. (This requirement must be fulfilled in conjunction with inspection activities set forth in NASA Quality Publication NPC 200-2.)

b. Functions in accordance with design specification and intent.

c. Will mate physically and functionally with other flight and ground support equipment items.

3.8.8.2 Requirements.

a. Manufacturing checkout of stages, modules, and GSE shall be in accordance with paragraph 3.8.8.1 objectives and tables 3-3 and 3-4. A manufacturing checkout run under other than ambient conditions may also be considered an environmental test (see paragraph 3.8.7).

b. The successful completion of manufacturing checkout is a prerequisite to assembly into a higher hardware generation level at another contractor's plant or NASA installation and for shipment to an acceptance static firing or installation site.

3.8.9 Static Firing Tests of Stages and Modules.

3.8.9.1 Objectives. Static firing tests on stages and modules are acceptance tests performed for the purpose of verifying the propulsion and control systems integrated performance and for verifying the capability of all systems to function under environments generated by engine (s) operating

under full thrust (or variable thrust where applicable) conditions.

3.8.9.2 Requirements.

a. Prior to delivery to the launch site, each liquid propulsive flight stage or module shall be subject to at least one captive firing to verify flight readiness of the individual stage or module (see table 3-3).

b. Upon receipt at a static firing facility, a stage or module to be tested shall undergo an inspection to determine if the configuration is adequate and if any damage has been incurred during transportation from the manufacturing facility. The extent of this inspection shall be determined by the cognizant NASA installation, but as a minimum, be as rigorous as that inspection which the item will receive in pre-mating checkout.

c. Pre-static firing checkout procedures and equipment and the test countdown shall duplicate, as nearly as practicable, those to be utilized during actual launch.

d. The flight sequence of events, such as engine cut-offs and restarts and simulated staging, shall be considered when planning static firing tests.

e. A detailed test procedure shall be generated for each static firing test. When generated by contractor activities, approval of the test procedure may be required at the discretion of the cognizant Center.

f. The static firing test measuring program shall include all measurements which are to be monitored during actual launch and flight. Since the vehicle flight instrumentation system is one of the items being tested, test measurements shall be acquired by facility instrumentation systems as well as the telemetry systems.

g. At the completion of static firing test and prior to maintenance, the tested stage or module shall be thoroughly checked out for structural, electrical, and functional integrity to assure that no system degradation has resulted from the static firing test.

functional integrity to assure that no system degradation has resulted from the static firing test.

3.8.10 Post-Static Firing Checkout of Stages and Modules

3.8.10.1 Objectives. Post-static firing checkouts of stages and modules are final acceptance tests performed for the purpose of verifying that the hardware is suitable for shipment to the launching site.

3.8.10.2 Requirements. After the tested stage or module is checked out in accordance with paragraph 3.8.9.2g, and after maintenance, the tested stage or module shall meet the paragraph 3.8.10.1 objectives and table 3-3 requirements. Post-static firing checkout shall be equivalent to manufacturing checkout (paragraph 3.8.8).

3.9 PRE-USE CHECKOUT AND VERIFICATION OF GROUND SUPPORT EQUIPMENT

3.9.1 Objective. The objective is to verify the initial and subsequent readiness of ground support equipment for use and to verify its operability with flight hardware.

3.9.2 Requirements. As a minimum, the following ground support equipment checkout requirements must be fulfilled:

a. Ground support equipment at the installation site shall be checked out initially through self verification or other appropriate means prior to connection with each item of space vehicle hardware. This acceptance test shall be performed in accordance with table 3-4. After connection of ground support equipment to space vehicle items, a systems compatibility check shall be made prior to beginning the checkout of the space vehicle item. Further verification of ground support equipment operability shall be made as appropriate during checkout of space vehicle items.

b. Subsequent pre-use checkouts shall be performed prior to each launch to verify the readiness of the ground support equipment.

c. Final verification tests of the ground support equipment shall be performed during subsequent flights of unmanned or manned space vehicles.

3.10 PRE-LAUNCH CHECKOUT OF SPACE VEHICLES

3.10.1 Objective. The primary objective of the pre-launch checkout is to determine that the assembled space vehicle is ready for launch.

3.10.2 Requirements.

3.10.2.1 KSC shall publish a pre-launch checkout plan for each space vehicle. Appropriate inputs to the plan will be provided by MSC and MSFC. The plan shall include as a minimum:

a. Pre-launch checkout operations to be conducted on stages, modules, and the space vehicle to verify readiness for launch.

b. Overall sequence and schedule for accomplishing space vehicle checkout operations.

c. KSC, MSC, MSFC and contractor responsibilities and relationships and contractor controls.

d. Working level test documentation and records requirements.

e. Elements of an operational readiness program such as logistics and reliability analysis.

The pre-launch checkout plan shall be coordinated with MSC and MSFC.

3.10.2.2 The pre-launch checkout shall include the following as a minimum:

a. Visual inspections to assure satisfactory physical condition.

b. Functional checkout and compatibility verification of all subsystems and all complete systems within the space vehicle not confined within a stage, module or IU. Includes verification of instrumentation calibrations.

c. Electromagnetic interference test.

d. Simulated flight.

3.11 POST-FLIGHT TEST

3.11.1 Objectives. Post-flight testing is conducted to determine the effects of space flight operation on flight hardware.

Emphasis shall be placed on the early identification of subsystems, assemblies or components which exhibit abnormal performance, unusual characteristics or appearance, and on measurement of the extent of the damage.

3.11.2 Requirements.

3.11.2.1 The post-flight test shall meet paragraph 3.11.1 objectives and be conducted in accordance with table 3-3 under the cognizance of the NASA Center responsible for the hardware development.

3.11.2.2 The determination of the number, types, and locations of post-flight tests necessary to meet the above objectives shall be the responsibility of the Centers.

SUMMARY GROUND TEST REQUIREMENT FOR FLIGHT HARDWARE

GENERATION LEVEL	TEST TYPE	FLIGHT TYPE HARDWARE ONLY		SPECIFIC GROUND TESTS-NOTE 1 PAR. 3.5	ACCEPTANCE TESTS					
		GROUND QUALIFICATION PAR. 3.6	RELIABILITY DEMONSTRATION PAR. 3.7		RECEIVING PAR. 3.8.3	IN-PROCESS TESTS: SCREENING PAR. 3.8.5	IN-PROCESS TESTS: AMBIENT PAR. 3.8.6	IN-PROCESS TESTS: ENVIRONMENTAL PAR. 3.8.7	1 MFG. C/O PAR. 3.8.8 2 POST-FLIGHT TEST PAR. 3.11 3 STATIC & POST-STATIC FIRING PAR. 3.8.9 & 3.8.10	PRE-LAUNCH C/O PAR. 3.10
PIECE PARTS (COMPONENTS AND MATERIALS)	REQUIRED ON	SAMPLE SIZE DETERMINED BY CENTER CRITICALITY 1, 2, 3	SAMPLE SIZE DETERMINED BY CENTER CRITICALITY 1,2		ALL UNITS	SELECTED ELECTRICAL ELECTRONIC OPERATING MECHANICAL COMPONENTS CRITICALITY 1, 2	ALL UNITS, IF COMPLETE FUNCTIONAL TEST OF THE UNIT CANNOT BE CONDUCTED AT NEXT HIGHER LEVEL.			
	COMPLETED PRIOR TO	MANUFACTURING C/O 1ST FLIGHT STAGE OR MODULE	MANUFACTURING C/O OF 1ST MANNED FLIGHT STAGE OR MODULE		INCORPORATION IN NEXT HIGHER LEVEL.	INCORPORATION IN NEXT HIGHER LEVEL	INCORPORATION INTO NEXT HIGHER GENERATION LEVEL.			
ASSEMBLIES	REQUIRED ON	SAMPLE SIZE DETERMINED BY CENTER CRITICALITY 1, 2, 3	SAMPLE SIZE DETERMINED BY CENTER CRITICALITY 1, 2		ALL UNITS		ALL UNITS, IF COMPLETE FUNCTIONAL TEST OF THE UNIT CANNOT BE CONDUCTED AT NEXT HIGHER LEVEL	ELECTRICAL ELECTRONIC ELECTRO MECHANICAL MECHANICAL CRITICALITY 1, 2		
	COMPLETED PRIOR TO	MANUFACTURING C/O OF 1st FLIGHT STAGE OR MODULE	MANUFACTURING C/O 1ST MANNED STAGE OR MODULE		INCORPORATION IN NEXT HIGHER LEVEL		INCORPORATION INTO NEXT HIGHER GENERATION LEVEL.	INCORPORATION INTO NEXT HIGHER LEVEL		
STAGES AND MODULES	REQUIRED ON	MINIMUM OF ONE UNIT		MINIMUM OF ONE UNIT FOR EACH TEST TYPE			ALL STAGES AND MODULES	ALL MODULES (EXCEPT I.U.)	ALL UNITS EXCEPT FOR POST FLIGHT TEST WHICH IS PERFORMED ON RECOVERABLE HARDWARE.	
	COMPLETED PRIOR TO	MANUFACTURING C/O OF 1ST FLIGHT STAGE OR MODULE		MANUFACTURING C/O OF 1ST FLIGHT STAGE OR MODULE			SHIPMENTS FROM MANUFACTURER	SHIPMENT FROM MANUFACTURER	1 SHIPMENT 2 DETERMINED BY CENTER 3 TRANSPORTING TO LAUNCH SITE	
LAUNCH VEHICLE SPACECRAFT AND SPACE VEHICLE	REQUIRED ON			SPACE VEHICLE, DYNAMIC TEST AND SYSTEMS COMPATIBILITY TESTS ONLY						SPACE VEHICLE
	COMPLETED PRIOR TO			MANUFACTURING C/O OF FIRST FLIGHT SPACE VEHICLE						LAUNCH
		1	2 3	4	5	6	7	8	9	

NOTE 1. SPECIFIC GROUND TESTS ARE DYNAMIC, STRUCTURAL, ALL-SYSTEMS, ND SYSTEMS COMPATIBILITY.

SUMMARY GROUND TEST REQUIRE :MENTS FOR GSE

GENERATION LEVEL	TEST TYPE	OPERATIONAL TYPE GSE ONLY			RECEI II P T	EIVING AND/OR IN-PROCESS PAR. 3.8.3 THRU 3.8.7	SCREENING PAR. 3.8.5	1 MAN. C/O PAR. 3.8.8 2 INSTALLATION SITE C/O PAR. 3.9.2.a 3 SYSTEMS COMPATIBILITY PAR. 3.9.2.a 4 FLIGHT DEV & VERIF. UNMANNED PAR. 4.4 & 4.5 5 FLIGHT DEV & VERIF MANNED PAR. 4.4 & 4.5
		RECEIVING PAR.3.8.3	RECEIVING AND/OR IN-PROCESS PAR. 3.8.3 THRU 3.8.7	GROUND QUALIFICATION PAR.3.6				
PIECE PARTS (COMPONENTS AND MATERIALS)	REQUIRED ON	'ALL FUNCTIONAL UNITS' CRITICALITY A, B, C		MINIMUM ONE UNIT CRITICALITY A, B, C	ALL F UNIT CRITI (RECE	FUNCTIONAL TS TICALITY A, B, C EIVING ONLY)	SELECTED ELECTRICAL ELECTRONIC OR ELECTRO-MECH. CRITICALITY A.	
	COMPLETED PRIOR TO	ASSEMBLY INTO NEXT HIGHER GENERATION LEVEL		SHIPMENT FIRST MAJOR GSE SYSTEM FROM MFG. PLANT	ASSE NEXT GENI	MBLY INTO T HIGHER ERATION LEVEL	ASSEMBLY INTO NEXT HIGHER GENERATION LEVEL	
ASSEMBLIES	REQUIRED ON		ALL OPERATIONAL TYPE UNITS CRITICALITY A, B, C	MINIMUM ONE UNIT CRITICALITY A, B, C	ALL U CRITI	UNITS ICALITY A, B, C		
	COMPLETED PRIOR TO		ASSEMBLY INTO NEXT HIGHER GENERATION LEVEI	SHIPMENT FIRST MAJOR SYSTEM FROM MFG. PLANT	INCC INTC GENI	ORPORATION O NEXT HIGHER ERATION LEVEL		
GSE MAJOR SYSTEM AND/OR MAJOR END ITEM	REQUIRED ON							ALL UNITS CRITICALITY A, B, C
	COMPLETED PRIOR TO							1 SHIPMENT FROM MFG. **2 SYSTEMS COMPATABILITY TEST** 3 USE DURING UNMANNED FLIGHT 4 MANNED FLIGHT 5 LUNAR MISSION

SECTION 4; FLIGHT TEST REQUIREMENTS

4.1 PURPOSE AND INTENT

Flight testing shall be employed to the extent necessary to insure crew safety and to provide a sufficient level of assurance of mission success.

4.2 OBJECTIVES

The prime objectives of flight tests are:

a. Evaluation of hardware characteristics and operational procedures which cannot be adequately evaluated by ground testing.

b. Acquisition of flight data and correlation of these data with the results of ground tests.

c. Flight verification of the launch vehicle prior to manned flight.

d. Flight verification of all spacecraft subsystems affecting crew safety prior to manned flight.

e. Flight verification of space vehicle and ground support equipment insofar as practical prior to manned flight.

f. Flight verification of spacecraft with man as an active part of the overall system.

g. Crew training.

4.3 GENERAL REQUIREMENTS

4.3.1 Mission Objectives. The number and types of mission objectives assigned to an individual flight shall be chosen to yield the maximum amount of useful engineering data and flight verification test time consistent with safe flight. In general, any specific flight, whether manned or unmanned, may embody a number of individual tests on different subsystems, stages or modules classified as stated.

4.3.2 Prerequisites. Ground qualification, reliability demonstration and Certification of Flight Worthiness requirements stipulated in paragraphs 3.6, 3.7, and 3.3.6 and in accordance with table 3-3 shall be fulfilled as prerequisites to unmanned flight tests.

Additional prerequisites are as follows:

a. Flight verification of equipment in criticality category 1 is required as a prerequisite to manned flight.

b. Each flight space vehicle shall be as complete as practicable i.e., no dummy stage, modules or subsystems

c. Lunar mission subsystems shall be utilized in all flight tests whenever practicable.

d. In each vehicle class, Saturn IB and Saturn V, each flight space vehicle shall be capable of fulfilling the basic mission objectives of the preceding vehicle, the only exception being that the extensive instrumentation required for spacecraft heat shield and early vehicle R&D flights of each class vehicle shall not be required for all flights of that vehicle.

4.3.3 Flight Hardware Use Restrictions.

4.3.3.1 Operating Time. The maximum allowable time (measured as total operating time, number of operations or cycles) for all time critical components and assemblies shall be established and records shall be kept of the cumulative totals. When the accumulated operating time plus the anticipated time during follow-on checkout and flight exceeds the maxinum, replacement must be made.

4.3.3.2 Flight Type Hardware. Hardware that has been subjected to development tests, qualification tests, or reliability demonstration tests shall not be incorporated into flight vehicles.

4.3.4 Checkout and Spare Requirements Prior to Launch. These requirements shall be in accordance with paragraph 3.3.7.

4.3.5 Test Equipment. The design of test equipment such as R&D instrumentation shall be such that their installation and removal may be made with minimum effects on the basic space vehicle operational system.

4.3.6 Launch Operations Plan. A launch operations plan shall be developed by KSC for Saturn IB and Saturn V with inputs supplied from the other Centers. This plan shall include provisions for fulfilling the requirements of the Flight Test Directives. (see paragraph 6.2.5.3). MSC shall be responsible for development of Little Joe II plans.

4.3.7 Mission Operations Plan. Mission Operations Plan shall be prepared and approved for each mission by the Director, Mission Operations, in accordance with Section 14 of the Program Development Plan.

4.3.8 Flight Test Reports. Flight test reporting requirements for each Apollo-Saturn Mission are summarized below. In the event of premature or unsuccessful termination of an Apollo-Saturn Mission, the requirements for security investigation procedures, data handling, and reporting will be those established by the Apollo Mission Failure Contingency Plan.

a. Twenty-four Hour Flash Report. (Mission Director) This report is required by the Mission Operations Director and issued by the Mission Director and will contain such data as launch and recovery time, statement of success based on general purpose, and listing of any observed significant anomalies of the flight and launch active ground support hardware.

b. Daily Operations Report. (Mission Director) For long duration manned Apollo Flight Missions there shall be a Daily Operations Report as required by the Mission Operations Director and issued by the Mission Director, which shall include major event chronology, and mission failure and anomalies identification.

c. Three-day Report. (KSC, MSFC, MSC) For Apollo flights, each Center shall supply a teletype report to the Apollo Program Director within three days after the launch of the flight. In the case of manned missions the MSC report shall be issued three days after mission completion. For the Centers specified, the data shall contain the following information:

(1) KSC Report. Space vehicle pre-launch checkout and final countdown anomalies summary, initial post launch complex status evaluations, and data retrieval status.

(2) MSFC Report. Identification and indication of the degree to which each of the launch vehicle objectives have been satisfied, identification of major launch vehicle trajectory results including comparison with predicted conditions. The report shall also identify launch vehicle failures and anomalies and the possible causes.

(3) MSC Report. The report will contain an identification and indication of the degree to which each of the spacecraft objectives have been satisfied, identification of major spacecraft trajectory results including comparison with predicted conditions. The report shall also identify spacecraft failures and anomalies and the possible causes.

d. Ten-day Reports. (MSFC, MSC)
For all Apollo flights, MSFC shall supply a teletype report within 10 days after launch. MSC will supply a teletype report 10 days after launch for unmanned flight and 10 days after mission completion for manned flights. These reports will be submitted to the Apollo Program Director and will update the applicable Center three-day reports and will include new anomalies and failures identified, their causes and possible failure modes.

e. Failure and Anomalies Listing Report. (KSC, MSFC, MSC)
Within 30 days after launch, MSC, MSFC, and KSC shall provide to the Apollo Program Director for each mission as applicable to Center responsibilities a listing of all significant flight and launch anomalies including significant malfunctions, performance deviations, and system, subsystem, or hardware failures. In the case of manned missions, the MSC listing is due 30 days after mission completion.

f. Final Flight Evaluation Report. (MSFC, MSC)
Final Flight Evaluation Report shall be prepared by MSFC and MSC, and shall be submitted within 45-60 days after the mission completion to the Apollo Program Director. (Additional 8 copies to be submitted to the Director, Apollo Test, Code MAT.)

g. Ground Systems Evaluation Report. (KSC)
A Ground Systems Evaluation Report shall be prepared by KSC and shall be submitted within 45-60 days after the mission completion to the Apollo Program Director. (Additional 8 copies to be submitted to the Director, Apollo Test, Code MAT.)

4.3.9 Failure Correction. Failure correction shall be a result of an investigation conducted in accordance with the Apollo Mission Failure Contingency Plan. In the event that a critical (Category 1) flight failure deficiency will not be corrected prior to follow-on flights, a deviation approval shall be obtained from the Apollo Program Director, Code MA, with copies to Associate Administrator for Manned Space Flight, Code M, and to the Director, Apollo Test, Code MAT (See Appendix A for procedure. Written notification of the corrective action taken on critical (Category 1) deficiencies corrected prior to follow-on flights shall be sent to the Apollo Program Director, Code MA, with a copy to the Director, Apollo Test.

4.3.10 Flight Data Evaluation and Correction of Critical Deficiencies. The Centers shall provide the necessary personnel and facilities to allow adequate reduction, analysis, and evaluation of data and correction of critical deficiencies between flights.

4.3.11 Orbital Refuse. MSC and MSFC shall plan to prevent the excessive accumulation of their respective equipment in earth or lunar orbit. The following shall be considered in test planning:

a. Orbital life of specific equipment.

b. Emission of electromagnetic radiation after equipment has fulfilled its use.

c. Equipment disintegrating in orbit.

d. Tracking of material and recording of location and trajectory.

4.4 FLIGHT DEVELOPMENT TEST

4.4.1 Objectives. To assure the proper functioning of the components of a system when exposed to actual operating conditions. Specific test objectives include: determination of feasibility of design approach, evaluation of hardware performance under actual environmental conditions, and evaluation of hardware failure modes and safety factors. The completion of the development phase of flight testing may involve the redesign retesting and modification of drawings and specifications.

4.4.2 Requirements.

a. The determination of the number and types of development tests necessary to meet paragraph 4.4.1 and flight mission objectives shall be the responsibility of the Centers.

b. The Centers shall determine when the design has progressed to the point where verification testing may commence. The individual flight test directives shall clearly identify the flight development tests.

4.5 FLIGHT VERIFICATION TEST

4.5.1 Flight Verification Test - Unmanned

4.5.1.1 Objectives. To demonstrate safe functioning and achievement of minimum performance requirements of the components of a vehicle or spacecraft system when exposed to unmanned operating conditions.

4.5.1.2 Requirements.

a. The determination of the number and types of unmanned flight verification tests necessary to meet paragraph 4.5.1.1 and flight mission objectives shall be the responsibility of the Centers.

b. The Centers shall state in each Mission directive the criteria which determine successful completion of the unmanned flight verification test. The actual determination of success or failure shall be made or approved by the Center based upon an analysis of flight data and a post-flight test of recovered equipment.

4.5.2 Flight Verification Test - Manned

4.5.2.1 Objectives. To demonstrate the operational suitability of equipment under the actual conditions it will encounter in fulfillment of a manned mission.

4.5.2.2 Requirements.

a. The determination of the number and types of tests required for manned flight verification shall be the responsibility of the Centers.

b. Each Mission Directive shall identify the verification flight for each subsystem and state the criteria for successful verification.

c. The determination of successful verification for each subsystem shall be the responsibility of the Center. This determination shall be based on an analysis of flight data and a post-flight test on recoverable equipment.

4.6 SPECIFIC REQUIREMENTS

The following minimum requirements shall be accomplished by the flight test programs listed below:

4.6.1 Minimum Pad Abort and Little Joe II.

a. Verification of the structural integrity of the Little Joe II launch vehicle.

b. Verification of the escape system and command module combination under at least the following conditions.

Simulated flight abort at:

(1) Maximum dynamic pressure conditions comparable to that anticipated in the Saturn IB/V missions.

(2) High altitude conditions requiring the use of the RCS system for stabilization.

4.6.2 Minimum Apollo/Saturn I Flight Test Requirements.

a. Verification of the launch vehicle, in individual stages and the instrument unit.

b. Determination of launch vehicle environment utilizing boilerplate Apollo spacecraft.

c. Determination of near earth orbit micrometeorite distribution.

4.6.3 Minimum Apollo/Saturn IB Unmanned Flight Test Requirements.

a. Verification of the Saturn IB launch vehicle.

b. Verification of Apollo CSM for earth orbital flight. (category 1 subsystems)

c. Reentry verification at supercircular reentry conditions.

4.6.4 Minimum Apollo/Saturn IB Manned Flight Test Requirements.

a. Verification of operational characteristics of the crew-equipment combination for orbital stay time of ten days (all categories).

b. Verification of CSM turn around and docking with LEM.

c. Verification of LEM rendezvous and docking with CSM in earth orbit.

d. Continue verification of ground support equipment.

e. Provide ground and flight crew training.

4.6.5 Minimum Apollo/Saturn V Unmanned Flight Test Requirements.

a. Launch Vehicle Verification

b. Verification of spacecraft for earth orbital flight (all category 1 subsystems).

c. Reentry verification at lunar return reentry velocity conditions.

4.6.6 Minimum Apollo/Saturn V Manned Flight Test Requirements.

a. Final verification of all subsystems including man-machine compatibility in a simulated Apollo mission in earth orbit.

b. Final verification of global networks or ground tracking, communication, command and telemetry system.

c. Manned lunar missions culminating in the actual lunar landing and return.

SECTION 5

BIOMEDICAL TEST REQUIREMENTS

5.1 PURPOSE AND INTENT

Biomedical tests shall be utilized to promote the environmental health and operational efficiency of ground test subjects and flight crews. The specific minimum test requirements for ensuring effective overall man-machine system performance will be presented in another section to be entitled "Flight Crew Performance Test Requirements."

5.2 OBJECTIVES

The prime objectives of biomedical tests are:

a. Evaluation of potential health hazards and establishment of compatibility of new materials, processes, assemblies, and sub-systems with the human physiological processes during all phases of the Apollo Program.

b. Verification that crew support equipment fulfills design and quality requirements needed for efficient operation of human subjects operating in the actual flight environment.

c. Establishment of confidence that the crew can perform adequately in flight and, to the extent that it does not interfere with crew performance, be instrumented in such a way as to furnish optimum data for reliability assessment.

d. Assurance of optimum collection of baseline physiological and psychological data in both ground and flight test programs for future mission planning.

5.3 GENERAL REQUIREMENTS

5.3.1 Ground Test Planning.

a. Health Hazards Evaluation. Ground tests shall incorporate biomedical tests to minimize the number and cost of developmental flight tests required to establish freedom from

health hazards and compatibility of all system components with normal physiological and psychological function. Whenever possible, appropriate unmanned tests shall be planned for various generation levels of hardware to assure that all toxic and environmental hazards are eliminated at the earliest possible point in the developmental program.

Human test subjects shall be employed in final health hazard testing only when:

1. All subsystems have been shown by appropriate test and analysis to be free of health hazards.

2. Appropriate analytic instrumentation is available to monitor the environment for buildup of trace contaminants.

3. System integration testing has reached a point where no untoward human-operator changes are expected.

4. Constant medical monitoring of the test subjects is available.

b. Environmental Testing of Personal Protective and Life Support Equipment. To insure that test and simulation plans are consistent with equipment operational design parameters and to minimize the potential risks to the health and safety of test subjects, all manned tests utilizing life support and personal protective equipment (including those conducted by contractors) will have a complete test program documented and approved by the Chief, Center Medical Programs, MSC. This documentation shall include detailed test protocol insuring that, as a minimum requirement, the following points have been satisfactorily covered:

1. Provision for adequate medical surveillance and support.

2. Provision for maximizing the collection of valid physiological, psychological, and equipment performance data consistent with test objectives.

3. Evaluation of all potential biomedical hazards.

4. Provision of adequate training of the test subject with the equipment and its utilization in the specific test or simulation.

Test subjects shall be chosen so as to simulate as closely as possible the performance characteristics of astronauts. Such astronaut-like subjects shall be used whenever their

use can be reasonably expected to yield valid data and when the use of astronauts or astronaut candidates would be unfeasible or inadvisable from other program standpoints. For final evaluation the astronauts themselves will be used, so that the information obtained can be used as a baseline for evaluation of possible changes under space conditions.

Tests shall be conducted to the maximum extent practicable under simulated mission conditions including anticipated combinations, sequences, and durations of stresses. Selection of natural and induced environments shall be in accordance with the Apollo Program Specification, SE005-001-1 and the Natural Environment and Physical Standards for the Apollo Program, SE015-001-1. The Centers acting under approval of the Chief, Center Medical Programs shall be responsible for determining the environment and the operating time or cycles in accordance with test policy and test requirements specified in this document.

5.3.2 Flight Test Planning.

5.3.2.1 Unmanned Flight Planning. Flight test of life support and personal protective equipment may be necessary for evaluation of hardware and operational characteristics which cannot be adequately performed by ground testing or simulation. Whenever such conditions exist, unmanned flight verification of critical spacecraft subsystems affecting the crew safety shall be accomplished prior to manned flight. These tests shall conform to the requirements specified in paragraph 4.5.1.2a. The criteria which determine successful completion of the unmanned verification shall be identified in the flight test plan under approval of the Chief, Center Medical Program, MSC. During such verifications, subject to state of the art and program limitations, physicochemical devices simulating the human contribution to life support subsystems shall be utilized. Ground qualification, reliability demonstration, certification of flight worthiness requirements for biomedical equipment, as stipulated in paragraphs 3.6, 3.7, and 3.3.6 in accordance with Table 3.3, shall be fulfilled as prerequisites to these unmanned tests.

5.3.2.2 Manned Flight Test Planning. Demonstration of the operational suitability of life support and personal protective equipment subsystem is a first order objective of the manned flight verification tests. The specific

verification flight for each of these subsystems and the criteria for successful verification shall be identified in the MSC Mission Directive under approval of the Chief, Center Medical Program, MSC.

Determination of successful verification for each life support subsystem shall be the responsibility of the Center and shall be based on analysis of flight data and post-flight test on recovered equipment.

5.3.2.3 In-Flight Biomedical Experiments. In-flight biomedical experiments will be approved by the MSFEB. Planning of in-flight biomedical experiments shall be the responsibility of the MSF Directorate of Space Medicine. Coordination with Program Offices and Centers shall be accomplished as specified in appropriate management instructions. The in-flight biomedical program shall be designed and coordinated to assure the collection of appropriate baseline and in-flight data to aid in future mission planning.

5.3.2.4 Standardization of Biomedical Data and Bio-Instrumentation. In-flight bio-instrumentation and related medical data collection and analytical procedures shall be designed to be compatible with related medical data schemes used to obtain baseline data. The Center responsible for the integration of bio-instrumentation into a spacecraft will be responsible for insuring compliance with this provision.

5.3.3 Critical Rating.

The Centers shall develop failure effects analysis programs for life support and personal protective systems which will be utilized as noted in Section 3.3.3 of this report. This listing shall be updated as required and shall be made readily available for test planning activities throughout NASA.

5.3.4 Priority Rating.

Centers shall develop a priority listing for tests in the biomedical area. This listing shall appear in the test plans for the appropriate stage, module, and GSE of the program (GSE Par. 6.2.4.5). Plans shall concentrate on areas of new or increased requirements. Applicable history or methods of prior tests shall be suitably referenced or incorporated into test plans.

5.3.5 General Procedures.

Certification of Flight Worthiness (COFW), checkout operations and flight plans, and identification of facilities and test equipment for biomedical tests shall follow planning procedures 3.3.6, 3.3.7, and 3.3.8 of this document.

5.4 DEVELOPMENT TESTS

Development tests for ground and flight testing of biomedical equipment and procedures shall follow, wherever applicable, the objectives and requirements noted in Sections 2.4 and 4.4 of this document.

5.5 SPECIFIC TEST REQUIREMENTS

Specific ground and flight verification tests of biomedical equipment and procedures shall, wherever applicable, follow the specific objectives and requirements noted in Sections 3.5 and 4.5 of this document.

Specific procedures for ground qualification testing, reliability demonstration testing, acceptance testing, pre-use checkout and verification of ground support equipment, pre-launch checkout and post-flight testing of biomedical equipment shall follow, wherever applicable, the objectives and requirements of Sections 3.6, 3.7, 3.8, 3.9, 3.10 and 3.11 of this document.

Biomedical aspects of specific flight test requirements shall be accomplished, wherever applicable, under the minimum requirements noted in Section 4.6 of this document. Life support equipment, personal protective equipment, and crew systems operations shall be verified under the specifications noted in the Apollo Program Specification, SE005-001-1, Sections 4.3.9 and 4.3.10.

5.6 BIOMEDICAL DOCUMENTATION REQUIREMENTS

5.6.1 General Requirements.

Compatible with equipment test requirements, all test documentation shall include but not be limited to the following minimum information:

a. Provision for maximizing the collection of valid physiological, psychological and equipment performance data, consistent with the test objectives.

d. Evaluation of all potential biomedical hazards to test subjects.

c. Provision for adequate medical surveillance and support.

d. Provision for adequate training and familiarity of the test subject with the equipment under test and its utilization in the specific test or simulation.

5.6.2 Center Documentation.

To be supplied.

5.6.3 Contractor Documentation.

Plans for contractor test programs shall be prepared to meet the requirements of paragraphs 5.6.1 and 6.2.4. Contractor conducted test programs, where appropriate, will be documented in the specification which is a part of the appropriate contractual document. All such specifications will contain requirements for a separate biomedical test section devoted to specifying test objectives, requirements and procedures. This section shall include but not be limited to a detailed test protocol covering the test program.

SECTION 6: DOCUMENTATION REQUIREMENTS

6.1 GENERAL

6.1.1 Test Plans. The Centers shall be responsible for the timely establishment of test plans which will reflect the fulfillment of the test requirements specified within this document. The Apollo Program Office will establish summary plans for the purpose of integration and evaluation of test activities and will publish the Apollo Flight Mission Assignments document. As a minimum, the Centers shall prepare test plans as required by table 6-1 and submit nine copies to Director, Apollo Test, Code MAT.

6.1.2 Supporting and Other Documents. In addition to test plans, there are many supporting documents which are essential to the effective fulfillment of the test requirements specified within this document. The Centers shall be responsible for the establishment of supporting documents as enumerated in table 6-2 and for the fulfillment of other documentation requirements in accordance with table 6-3.

6.1.3 Documentation Schedule. The fulfillment of the test plan requirements depends upon the documentation schedule. Consequently, times for completing documents are stipulated herein. It is recognized that certain detailed information may not be available at the time of first issue of a specific document. However, the document should be issued at that time with completion of the missing elements at a later time. Revisions should be published to documents when significant changes are made to plans which interface with other NASA installations or as otherwise deemed appropriate by the Centers.

6.1.4 Test Schedules and Review Procedures. This document does not purport to cover the establishment of test schedules nor a review system for use during the implementation phase. The MSF monthly scheduling and review procedures already established with the Centers have been developed for this purpose. The Manned Space Flight monthly schedules set forth the schedules to be considered in the establishment of test plans. A set of nominal time periods and dates are to be utilized in the preparation of the test plans requested in section 6. Matrices developed shall indicate that the times shown are nominal.

6.2 TEST PLANS

The following plans shall be established to implement the test requirements specified within this document:

6.2.1 Apollo Test Plan Summary. An Apollo Test Plan Summary will be prepared and issued by MSF to depict the integration of the major ground test and flight test programs. The intent is to present on a single plan an integrated and consolidated top level summary of various test planning data developed by the Centers. This summary will show:

a. The major activities of the ground test program down to and including the stage and module level.

b. Significant events and constraints within each of the major activities.

c. The flight program showing flight schedules and individual flight missions.

d. Identification of major test hardware and test facilities in the program.

The time phasing of data presented in the summary will be based on Center inputs submitted in accordance with OMSF Program Scheduling Manual M-IM9330.006, 007 and 008 dated Sept. 1963 as amended by MI MP9330.052 dated February 16, 1965.

6.2.2 Apollo Flight Mission Assignments (See paragraph 1.3)

a. This document is a Flight Mission Assignments Summary Directive. It shows the flight test Configuration and Flight Data Summary Charts for Apollo/Saturn and Apollo/Little Joe II on an individual flight-by-flight basis.

b. Periodic revisions will be made by MSF as flight missions are better defined and changes are approved.

6.2.3 Master Test Plans for Launch Vehicles and Spacecraft. The Centers shall be responsible for the preparation of master test plans for launch vehicles and spacecraft in accordance with table 6-1. These plans shall describe the overall ground and flight test development plan and identify the test program requirements and test activity to be accomplished by the stage or module contractors and the appropriate Center. They shall also indicate the integration of these activities leading to the successful conduct of the lunar mission. As a minimum,

the overall test plan at the multiple subsystem and module or stage level shall be identified and the relationship indicated between these tests, the subsystem qualification program, and the checkout validation (prior to launch operations.) They shall include the planning associated with acceptance and checkout testing. They shall provide the basis for more detailed stage or module test plans as well as individual test article and component test plans. Test constraints relative to key ground and flight tests are to be indicated. The test requirements which require Center approval are to be specified and the method of obtaining such approval.

Master test plans shall contain as a minimum the following:

a. Center Test Requirements

(1) Center test policies.

(2) Specific test requirements.

(3) Test document requirements including test tree diagram, scope and content of each document and list and description of supporting document.

b. Overall Test Plan Schedule and Logic

(1) Launch vehicle or spacecraft tests

(2) Major stage or module tests

(3) Qualification test program

(4) Reliability test program

(5) Documents

c. Summary of Stage and/or Module Contractor Test Programs

(1) For specific hardware or category of hardware: test specification, test environments, number of test specimens, and schedules.

(2) Supporting documentation

6.2.4 Test Plans for Each Stage and Module (Including IU and Spacesuit) and Associated Ground Support Equipment. The Centers shall be responsible for preparation of the following plans in accordance with table 6-1.

6.2.4.1 Ground Test Program Network. This information shall cover hardware down through the stage and module level. It shall consist of a network as set forth in table 6-4, along with supplementary sheets as required. It shall identify all stage and module ground test activities indicating at least the following for each test activity:

a. Purpose and location of test.

b. Hardware utilized indicating the quality of major subsystems involved.

c. Magnitude of test effort, i.e., duration, numbers of tests, level of instrumentation.

d. Identification of constraints from previous tests, and constraints dependent on test.

e. Facilities requirements.

6.2.4.2 Qualification and Reliability Demonstration Test Matrix. This plan shall cover hardware down through the assembly level, and shall include the data set forth in table 6-5. It shall reflect the fulfillment of requirements of paragraphs 3.6 and 3.7.

6.2.4.3 Acceptance Test Program Plan. This plan shall cover tests of hardware from receiving tests through premating checkout for space vehicles and systems compatibility check for GSE and include:

a. Guidelines necessary to assure compliance with paragraphs 3.8 and 3.9 through 3.9.2a.

b. Test types to be performed for components, subsystems and systems: (e.g., hydraulic system hardware, guidance and control system hardware, etc.)

c. Test sequences and flow plans.

d. Test techniques.

e. References to detailed control documents.

6.2.4.4 Piece Part and Component Qualification and Reliability Demonstration Program Plan. The following shall be included in the plan:

a. The categories of hardware (e.g., relays, transistors, and diodes) to be subjected to qualification tests and reliability demonstration tests.

b. The specifications to which the hardware is to be qualified.

c. The general schedules for the implementation (including completion) of qualification tests and reliability demonstration tests.

d. Number of specimens to be tested by categories, when applicable.

e. General program guidelines to fulfill the requirements of paragraphs 3.6 and 3.7 of this document.

6.2.4.5 Listing of Criticality and Priority Ratings. Listing of criticality and priority ratings of all hardware shall be developed for each stage and module in accordance with the requirements of paragraphs 3.3.3 and 3.3.4.

6.2.5 Test Plans for Space Vehicles. The Centers shall be responsible for preparation of the following plans in accordance with table 6-1.

6.2.5.1 Pre-Launch Checkout Plan. This plan shall include general plans for fulfillment of requirements specified in paragraph 3.10 of this document.

6.2.5.2 Mission Directives for Individual Flights

a. Mission directives for each individual Saturn IB, Saturn V and Little Joe II flight and each pad abort shall be prepared to fulfill the requirements stipulated in this document. These directives shall be consistent with applicable operational requirements established in Section 14 of the Program Development Plan and the Apollo Flight Mission Assignments, SE010-000-1 (see paragraph 6.2.2 above). This Mission Assignments document indicates that some missions are to be planned as either manned or unmanned flights. This duality of flight missions should be reflected in the individual mission directives.

b. A completed approved mission directive for each mission will consist of:

(1) A MSF directive that identifies the principal mission requirements and references and approves the specific Center mission directives.

(2) Center mission directives prepared by MSC and MSFC.

c. Individual Center mission directives shall be prepared by MSC and MSFC for each flight test in accordance with the following requirements:

Center Mission Directives

Publication : 18 months prior to launch if time permits, otherwise, as soon as possible. Directives shall be updated as necessary.

Coordination : Prior to publication, interface coordination with other Centers is required. Each Center's document shall have a sign-off by the other Centers verifying that this requirement has been met. No such coordination is necessary for MSC White Sands Operations flight tests.

Transmittal to MSF : Nine copies of the directive and subsequent changes are to be transmitted to Director, Apollo Test, Code MAT.

Approval Requirement : Approval of the Center mission directives will be accomplished through a review of Center mission directives and the issuance of the covering MSF mission directive mentioned in item (b) above. Changes to individual mission directives which conflict with the MSF prepared covering directive require approval of the Apollo Program Director. Other detailed changes to individual mission directives shall be submitted to Director, Apollo Test, for information.

d. The Center mission directives are to provide a single authoritative identification and control of the requirements, objectives, assignment of responsibilities, and specific details of implementation for individual flights consistent with Center responsibilities. Mission directives shall include:

(1) Introduction: Document purpose, precedence, scope, revisions, and responsibilities.

(2) Mission Objectives: General mission purpose, primary and secondary mission objectives, detailed listing of objectives.

(3) Mission Description: Powered flight, post insertion, abort capability, alternate missions.

(4) Launch Vehicle Description: Hardware configuration with emphasis on differences from previous hardware.

(5) Spacecraft Description: Hardware configuration with emphasis on differences from previous hardware.

(6) Mission Supporting Tests: Summary of supporting ground tests.

(7) Objectives Evaluation Criteria: Rationale for objectives, measurement requirements keyed to objectives.

(8) Instrumentation Requirements and Checkout: References to appropriate instrumentation lists and documents. Summary plan of major checkout phases.

NOTE: Items 9, 10, 11 and 12 are to be treated in summary form concentrating on general requirements identified to support the mission objectives. The primary detailed treatment is to be accomplished in appropriate mission operations documents. Such documents should be referenced.

(9) Operations Activities

(10) Pad and Range Safety Requirements

(11) Tracking and Support Data Requirements: Brief summary of tracking, photographic, meteorological and atmospheric data and data disposition requirements.

(12) Recovery Requirements

(13) Post-flight Tests: Summary of planned post-flight inspection/tests.

(14) Data Processing, Analysis, and Reporting: Brief description of data processing and post-flight reporting plan.

(15) Ground Support Equipment: References to GSE documentation listings.

Appendix A: Definitions, abbreviations

Appendix B: Interface control documents

Appendix C: References

Distribution

The primary objectives of the mission shall be those identified in the Apollo Flight Mission Assignments, SE010-000-1. When appearing in the mission directive they may be amplified, but not modified, as required by the Centers. The primary objectives are those which are mandatory. Malfunctions of spacecraft or launch vehicle systems, ground equipment, or instrumentation which would result in failure to achieve these objectives will be cause to hold or cancel the mission until the malfunction has been eliminated.

The secondary objectives are those which are desirable but not mandatory. Malfunctions which would result in failure to attain these objectives may be cause to hold or cancel the mission as indicated in the Mission Rules.

Flight hardware configurations specified in Center mission directives shall be consistent with those identified in the Apollo Flight Mission Assignments, SE010-000-1.

6.3 TEST SPECIFICATION AND TEST PROCEDURES

Test specification and/or test procedures shall be prepared to specify test parameters, test limitation, test equipment, and test methods (see table 6-2).

6.4 TEST REPORTS

Test reports specified herein shall be prepared as a minimum for communication and evaluation of test results (see table 6-2).

6.5 UNSATISFACTORY CONDITION REPORTS (UCR)

The Centers shall prepare and implement a uniform failure reporting and corrective action system covering all unsatisfactory conditions (such as defects, failures, and malfunctions) that occur during testing. The implementation shall be in accordance with NASA Reliability Publication, NPC 250-1, NASA Quality Publication, NPC 200-2, and Apollo Reliability and Quality Assurance Program Plan, RA001-000-1.

TABLE 6-1

DOCUMENTATION REQUIREMENTS (Continued)

TEST PLANS

	Plan	Reference Paragraph (This document)	Responsibility for Preparation	Plan Completion Date	
1.	Apollo Test Plan Summary	6.2.1	MSF	June 1965	
2.	Apollo Flight Mission Assignments	6.2.2	MSF	Revision	Mar. 1965
3.	Master Test Plans for Launch Vehicles and Spacecraft	6.2.3	MSFC & MSC	Revision	Apr. 1965
4.	Test Plans for Each Stage and Module (Including Associated Ground Support Equipment)	6.2.4.1, Table 6-4 6.2.4.2, Table 6-5 6.2.4.3 6.2.4.4 6.2.4.5		Most Recent Issue or Completion Date	
				Saturn IB	Saturn V
	S-IB		MSFC	Jan. 1965	
	S-IVB		MSFC	Jan. 1965	Jan. 1965
	S-IC		MSFC		Nov. 1964
	S-II		MSFC		Jan. 1965
	IU		MSFC	Jan. 1965	Jan. 1965

TABLE 6-1

DOCUMENTATION REQUIREMENTS (Continued)

TEST PLANS

Plan	Reference Paragraph (This document)	Responsibility for Preparation	Most Recent Issue or Completion Date	
			Saturn IB	Saturn V
GSE (launch vehicle)		MSFC	Apr. 1965	Apr. 1965
CSM		MSC	Feb. 1965 (Block I)	To be determined (Block II)
LEM		MSC	Jan. 1965	
G&N		MSC	Jan. 1965	
Spacesuit		MSC	Oct. 1964 (Block I)	Sept. 1965 (Block II)
5. Test Plan for Space Vehicles (Including Associated Ground Support Equipment)			Completion Date	
a. Pre-Launch Checkout Plans	6.2.5.1	KSC	One year prior to launch	
b. Mission Directives	6.2.5.2	MSC & MSFC	Eighteen (18) months prior to launch where time permits. Others as soon as possible.	

TABLE 6-2

DOCUMENTATION REQUIREMENTS (Continued)

SUPPORT DOCUMENT REQUIREMENTS BY TEST TYPE

Item No.	Test Type	Test Requirement Reference	Supporting Documents Requirements
	Ground Tests -		
1	Development Test	3.4 3.5	Test Specification Test Procedures Test Reports
2	Qualification Test	3.6	Test Specification Test Procedures Test Reports
3	Reliability Demonstration Test	3.7	Test Specification Test Procedures Test Reports
4	Acceptance Test	3.8 3.9 thru 3.9.2a	Test Specification Test Procedures Test Reports
5	Pre-Use and Verification Checkout of GSE	3.9.2.b & c	Test Procedures Test Reports
6	Pre-Launch Checkout of Space Vehicles	3.10	Test Procedures Test Reports

TABLE 6-2

DOCUMENTATION REQUIREMENTS (Continued)

SUPPORT DOCUMENT REQUIRMENTS BY TEST TYPE (Continued)

Item No.	Test Type	Test Requirement Reference	Supporting Documents Requirements
7	Post - Flight Test	3.11	Test Procedures Test Reports
	Flight Tests (Unmanned and Manned)		
8	Flight Development Test	4.4	Test Specification Test Procedures Test Reports (see para. 4.3.9)
9	Flight Verification Test	4.5	Test Specification Test Procedures Test Reports (see para. 4.3.9)

TABLE 6-3

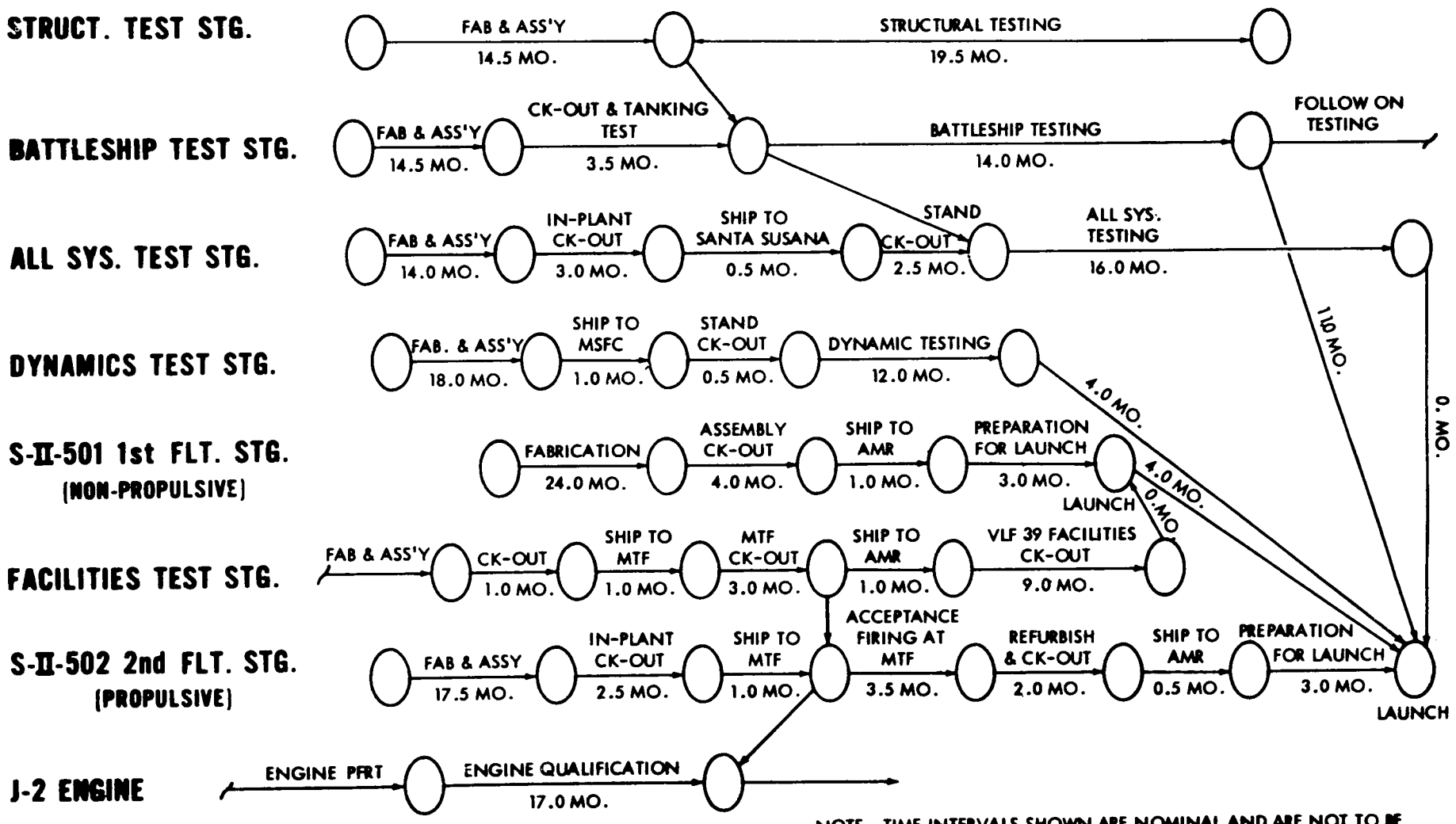
DOCUMENTATION REQUIREMENTS (Continued)

OTHER ATR DOCUMENTATION REQUIREMENTS

Item No.	ATR Requirement	Paragraph Reference
1	**Certificate of Flight Worthiness**	3.3.6
2	Spares Plan	3.3.7
3	Spares Test Data Log	3.3.7.c
4	Spares Accumulated Operations Time Log	3.3.7.c
5	Flight Hardware Operating Time Records	4.3.3.1
6	Launch Operations Plan	4.3.6
7	Mission Operations Plan	4.3.7
8	Flight Test Reports	4.3.8
9	Unsatisfactory Condition Report (UCR)	6.5

TABLE 6-4

S - II STAGE - GROUND TEST PROGRAM NETWORK (SAMPLE)



NOTE: TIME INTERVALS SHOWN ARE NOMINAL AND ARE NOT TO BE USED FOR SCHEDULING PURPOSES.

TABLE 6-5

DOCUMENTATION REQUIREMENTS

QUALIFICATION AND RELIABILITY DEMONSTRATION TEST MATRIX

SAMPLE

HARDWARE IDENTIFICATION			GROUND TESTS	
LEVEL	GENERATION BREAKDOWN	'HARDWARE CRITICALITY CATEGORY'	'QUALIFICATION' (TO BE COMPLETED PRIOR TO FIRST UNMANNED FLT)	'RELIABILITY DEMONSTRATION TESTS' (TO BE COMPLETED PRIOR TO 1ST MANNED FLT)
'STAGE' OR 'MODULE'	INST. UNIT			
'SUBSYSTEM'	GUID. & CONTROL			
'ASSEMBLY'	STAB. PLATFORM	2	TEST PLAN # SECTION # PAR. #	TEST PLAN # SECTION # PAR. #
	MOD I			
	MOD II			

'FLIGHT TESTS'

LEVEL	GENERATION BREAKDOWN	LITTLE JOE II								SATURN I									
		PA 1	PA 2	LJ II-1	LJ II-2	LJ II-3	LJ II-4	LJ II-5	LJ II-6	SA 1	SA 2	SA 3	SA 4	SA 5	SA 6	SA 7	SA 8	SA 9	SA 10
		UNMANNED								UNMANNED									
'STAGE' OR 'MODULE'	INST. UNIT																		
'SUBSYSTEM'	GUID. & CONTROL											D	D	D	D	D	D	D	D
'ASSEMBLY'	STAB. PLATFORM																		
	MOD I																		
	MOD II																		

LEVEL	GENERATION BREAKDOWN	SATURN I-B										SATURN V									
		SA 201	SA 202	SA 203	SA 204	SA 205	SA 206	SA 207	SA 208	SA 209	SA 210	SA 501	SA 502	SA 503	SA 504	SA 505	SA 506	SA 507	SA 508	SA 509	SA 510
		UNMANNED					MANNED					UNMANNED						MANNED			
'STAGE' OR 'MODULE'	INST. UNIT																				
'SUBSYSTEM'	GUID. & CONTROL	D	D																		
'ASSEMBLY'	STAB. PLATFORM			D	V	O	O	O	O	O	O	D	D	V	O	O	O	O	O	O	O
	MOD I																				
	MOD II																				

HOW 'GENERATION LEVEL' BREAKDOWN TO ASSEMBLY LEVEL. MODEL CHANGES OF ITEMS SHALL BE SHOWN

HARDWARE CRITICALITY CATEGORY NUMBER AS DEFIND IN TABLES 3-1 & 3-2

AN ENTRY IN THIS COLUMN INDICATES ITEM WILL BE RELIABILITY DEMONSTRATION TESTER THE ENTRY SHALL REFERENCE THE SECTION AND PARAGRAPH NUMBER IN THE CENTER TEST PLAN THAT DETAILS THE TEST REQUIREMENTS.

AN ENTRY IN THIS COLUMN INDICATES ITEM WILL BE GROUND QUALIFIED PRIOR TO FIRST FLIGHT. THE ENTRY SHALL REFERENCE THE SECTION AND PARAGRAPH NUMBER IN THE CENTER TEST PLAN THAT DETAILS THE TEST REQUIREMENTS.

"D" INDICATES 'FLIGHT DEVELOPMENT TEST' OF ITEM

"V" INDICATES 'FLIGHT VERIFICATION TEST' OF ITEM

"O" INDICATES OPERATIONAL STATUS FOR DEFINITIONS SEE APPENDIX B

SECTION 7

APPROVED DEVIATIONS FOR THE APOLLO SPACECRAFT SATURN IB AND SATURN V

7.1 PURPOSE

This section will identify deviations which have been approved in accordance with the Deviation Approval Procedure required by Appendix A. The deviations will be grouped as follows:

	Pages
Spacecraft	7A-1 through
Saturn IB	7B-1 through 7B-6
Saturn V	7C-1 through 7C-4

1. DEVIATION APPROVAL REQUEST - NASA · MSFC APOLLO TEST REQUIREMENTS		
2. URGENT [X] YES [ ] NO	3. NUMBER: Sheet 1 of 1	4. REQUEST NUMBER: 1
5. ATR PARAGRAPH REFERENCE: 3.3.3	6. TITLE: Criticality Categories	7. STAGE OR HARDWARE AFFECTED: S-IVB

8. SPECIFIED REQUIREMENTS:

"3.3.3 CRITICALITY CATEGORIES

The Centers shall develop a failure effect analysis system which will be utilized to establish the criticality categories of hardware in accordance with Table 3-1."

9. DESCRIPTION OF DEVIATION:

Saturn IB-S-IVB stage category definitions are not in accordance with Table 3-1. The S-IVB stage defines only two categories:

Flight Critical - those whose single failure may cause loss of the stage.

Non-Flight Critical - those whose failure will not cause loss of the stage.

10. REASON FOR REQUEST:

S-IVB Flight Critical hardware includes both the ATR category 1 and 2 definitions. Since the test requirements specified in Table 3-3 of the ATR make no distinction between criticality category 1 and 2 and since the S-IVB flight critical category includes ATR category 1 and 2, the intent of the ATR is being met. Redirection of contractor effort at this time in the Saturn IB Program to bring about strict compliance with the ATR is undesirable due to excessive cost and schedule delay required to revise documentation and retrain personnel. It is recommended that the current S-IVB Stage definitions be retained.

11. CONCURRENCE:

Manager, S-IVB (IB) Stage	12/23/65 DATE
	DATE
	DATE
	DATE
	DATE

12. MSFC APPROVAL:

Chief, Saturn I/IB Test Office	Dec 23, 65 DATE
Manager, Saturn I/IB Program	29 Dec 65 DATE

13. MAT APPROVAL [X] **DISAPPROVAL** [ ]

Director, Apollo Test	1/28/66 DATE
See Item 14	DATE

14. REMARKS:

Approved for SA-201. The establishment of hardware criticality categories 1 and 2 is still required for vehicles after SA-201. The scope of contractor participation, however, may be limited to analysis work and failure reporting.

1. DEVIATION APPROVAL REQUEST - NASA MSFC APOLLO TEST REQUIREMENTS		
2: URGENT ☒ YES ☐ NO	3. NUMBER: Sheet 1 of 1	4. REQUEST NUMBER: 2
5. ATR PARAGRAPH REFERENCE: 3.3.3	6. TITLE: Criticality Categories	7. STAGE OR HARDWARE AFFECTED: GSE

8. SPECIFIED REQUIREMENTS:

"3.3.3 CRITICALITY CATEGORIES

The Centers shall develop a failure effects analysis system which will be utilized to establish the criticality categories of GSE hardware in accordance with Table 3-2."

9. DESCRIPTION OF DEVIATION:

No formal or integrated failure effects study has been conducted to establish criticality categories of GSE hardware in accordance with Table 3-2.

10. REASON FOR REQUEST:

Each responsible agency has determined the critical nature of major GSE end items and tested accordingly (example: Extensive tests and analysis of Umbilical Connectors). Certain GSE items which are known to fall in the ATR critical categories are so designated in the test plans, however the listings are incomplete. Designations are being added to the plans as they become available. The cost impact of instituting a contractor integrated criticality study would be great and would not be meaningful at this time for the Saturn IB Program due to the time required to conduct the study and implement its results.

11. CONCURRENCE:

Manager, Vehicle GSE	12/23/65 DATE
	DATE
	DATE
	DATE
	DATE

12. MSFC APPROVAL:

Chief, Saturn I/IB Test Office	Dec 23, 65 DATE
Manager, Saturn I/IB Program	29 DEC 65 DATE

13. MAT APPROVAL ☐ DISAPPROVAL ☐

Director, Apollo Test	1-28-66 DATE
See Item 14	DATE

14. REMARKS:

Approved for SA-201. The establishment of hardware criticality categories A and B is still required for vehicles after SA-201. To the extent possible without increasing the contractors' scope of work, require completion of such listing by MSFC prior to the FRR for AS-202.

1. DEVIATION APPROVAL REQUEST - NASA · MSFC APOLLO TEST REQUIREMENTS

2. URGENT	3. NUMBER:	4. REQUEST NUMBER:
☒ YES ☐ NO	Sheet 1 of 1	3

5. ATR PARAGRAPH REFERENCE:	6. TITLE:	7. STAGE OR HARDWARE AFFECTED:
3.3.4	Test Emphasis	S-IB, IU S-IVB, GSE

8. SPECIFIED REQUIREMENTS:

"3.3.4 TEST EMPHASIS

The centers shall develop a priority listing of all hardware for each stage, module, and GSE. This listing shall appear in the test plans for the appropriate stage, module, and GSE (Paragraph 6.2.4.5). Test emphasis shall be based on a priority rating."

9. DESCRIPTION OF DEVIATION:

The development of a priority listing of all hardware to be utilized in determining test emphasis has not been accomplished.

10. REASON FOR REQUEST:

The implementation of such a priority listing was precluded due to the program schedules. Factors similar to those recommended in the ATR have been considered in determining test emphasis by the responsible design organizations.

11. CONCURRENCE:

Arthur W. Thompson Manager, S-IB Stage	12/23/65 DATE
Roy E. Ratfey Manager, S-IVB (IB) Stage	12/23/65 DATE
William Simmons Manager, IU Project	12/29/65 DATE
[illegible] Manager, Vehicle GSE	12/28/65 DATE
	DATE

12. MSFC APPROVAL:

Joseph E. Fikes Chief, Saturn I/IB Test Office	Dec 23, 65 DATE
Kurt R. Stehling Manager, Saturn I/IB Program	29 Dec 65 DATE

13. MAT APPROVAL ☒ **DISAPPROVAL** ☐

Melvin Savage Director, Apollo Test	1-28-66 DATE
	DATE

14. REMARKS:

1. DEVIATION APPROVAL REQUEST - NASA · MSFC APOLLO TEST REQUIREMENTS

2. URGENT	3. NUMBER:	4. REQUEST NUMBER: 4
[X] YES [ ] NO	Sheet 1 of 1	

5. ATR PARAGRAPH REFERENCE: 3.5.3.2	6. TITLE: System Compatibility Tests	7. STAGE OR HARDWARE AFFECTED: S-IB, IU S-IVB, GSE

8. SPECIFIED REQUIREMENTS:

"3.5.3.2 REQUIREMENTS

As a minimum, systems compatibility tests shall provide reasonable assurance that: stages, modules, launch vehicle, and spacecraft (for the specific configuration to be flown) are physically, functionally and operationally compatible prior to shipment of the first flight stages and modules to the test site; and stages, modules, or space vehicle are compatible with ground support equipment at a manufacturing plant, static firing test area, and the launch area, prior to shipment of the first flight hardware (for the specific configuration to be flown) to the above areas."

9. DESCRIPTION OF DEVIATION:

The requirement for systems compatibility tests to assure that all flight configured hardware (including GSE) is completely compatible prior to shipment of the first flight hardware was not accomplished.

10. REASON FOR REQUEST:

Excessive cost schedule pressure and unavailability of hardware precluded achievement of this requirement. System compatibility data at the stage and vehicle level was obtained from hardware (including flight hardware) provisioned for other phases of testing, for example: The MSFC Breadboard facility, the facility checkout at KSC, the Dynamic Test Vehicle and for the S-IVB the EDSIL facility at the Douglas plant. We anticipate that this approach will satisfy all form and fit requirements and the majority of the functional requirements. These tests will remain under continued surveillance by the Saturn I/IB Test Office to insure that program objectives are met.

11. CONCURRENCE:

Arthur W. Thompson Manager, S-IB Stage	12/23/65 DATE
for Roy E. Godfrey Manager, S-IVB (IB) Stage	12/23/65 DATE
William K. Simmons Manager, IU Project	12/29/65 DATE
[illegible] Manager, Vehicle GSE	12/29/65 DATE
	DATE

12. MSFC APPROVAL:

Joseph E. Fisher Chief, Saturn I/IB Test Office	Dec 23 65 DATE
[illegible] Manager, Saturn I/IB Program	29 Dec 65 DATE

13. MAT APPROVAL [X] DISAPPROVAL [ ]

Melvin Savage Director, Apollo Test	1-28-66 DATE
	DATE

14. REMARKS:

1. **DEVIATION APPROVAL REQUEST - NASA MSFC APOLLO TEST REQUIREMENTS**

2. URGENT	3. NUMBER:	4. REQUEST NUMBER:
[X] YES [ ] NO	Sheet 1 of 2	5

5. ATR PARAGRAPH REFERENCE:	6. TITLE:	7. STAGE OR HARDWARE AFFECTED:
3.6.2a	Ground Qualification Tests	S-IB, IU S-IVB

8. SPECIFIED REQUIREMENTS

"3.6.2a REQUIREMENTS

Ground qualification tests and specific ground tests (paragraph 3.5) shall be performed on a sample of flight type production hardware in accordance with table 3.3." Table 3-3 requires completion of ground qualification of criticality category 1, 2 and 3, piece parts (components) prior to manufacturing checkout of the 1st flight stage or module.

9. DESCRIPTION OF DEVIATION:

1. The current qualification test program will not qualify all criticality category 1, 2 and 3 piece parts (components).
2. Ground qualification will not be completed prior to manufacturing checkout of the 1st flight stage or module.

10. REASON FOR REQUEST:

1. Cost and schedule impacts preclude qualification of all criticality category 1, 2 and 3 items. Flight critical (criticality category 1 and 2) components and launch mandatory environments are being identified. Those components which fall into the flight critical category for the first flight will be qualified to the launch mandatory environments identified for the first flight. Qualification of these flight critical components will be completed prior to the first flight. The qualification of the remainder of the flight critical components will be completed prior to the first

11. CONCURRENCE:

Arthur W. Thompson Manager, S-IB Stage	12/23/65 DATE
R. E. Rabe Manager, S-IVB (IB) Stage	12/23/65 DATE
William K. Emmons Jr. Manager, IU Project	12/29/65 DATE
	DATE
	DATE

12. MSFC APPROVAL:

Joseph E. Fisher Chief, Saturn I/IB Test Office	Dec 23, 65 DATE
Lee B. Jamm Manager, Saturn I/IB Program	29 Dec 65 DATE

13. MAT APPROVAL [ ] DISAPPROVAL [ ]

Nelson Savage Director, Apollo Test	1-28-66 DATE
See Item 14	DATE

14. REMARKS:

Approved in principle but with the provision that those Category 3 items which would significantly degrade reliability or be a cause for holding a launch should be identified and qualified as soon as possible but no later than the first manned flight.

Item 10. REASON FOR REQUEST (Continued):

manned flight.

2. Significant changes to the test schedules to provide qualification completion prior to manufacturing checkout of the 1st flight stage or module presented prohibitive cost and launch schedule impact. A best effort was made to comply with ATR in the area of Qualification testing as presented above.

1. **DEVIATION APPROVAL REQUEST - NASA · MSFC APOLLO TEST REQUIREMENTS**

2. URGENT	3. NUMBER:	4. REQUEST NUMBER:
☒ YES ☐ NO	Sheet 1 of 2	6

5. ATR PARAGRAPH REFERENCE:	6. TITLE:	7. STAGE OR HARDWARE AFFECTED:
3.7.2.1	Reliability Demonstration Tests	S-IB, IU S-IVB

8. SPECIFIED REQUIREMENTS:

"3.7.2.1 TEST LEVELS

Reliability demonstration tests shall be performed on flight type hardware in accordance with table 3-3." Table 3-3 requires all criticality 1 and 2 flight type hardware to undergo reliability demonstration testing prior to manufacturing checkout of the 1st manned flight stage.

9. DESCRIPTION OF DEVIATION:

1. Reliability demonstration tests will not be conducted on all criticality 1 and 2 hardware.
2. Reliability tests are not being completed prior to manufacturing checkout of the 1st manned stage.

10. REASON FOR REQUEST:

1. The cost/schedule impact of reliability demonstration testing of all category 1 and 2 components and assemblies is prohibitive. A limited group of critical items will be selected for reliability demonstration tests. This group will remain under continued review to assure that the test candidates are currently the most crucial on the basis of their criticality, complexity, need for additional assurance of reliability, and failure history during other testing. The remaining items will be certified for flight on the basis of the confidence obtained from component qualification and other testing.

11. CONCURRENCE:

Arthur W. Thompson Manager, S-IB Stage	12/23/65 DATE
Kay E. Rathjen Manager, S-IVB (IB) Stage	12/23/65 DATE
William C. Simmons Jr. Manager, IU Project	12/29/65 DATE
	DATE
	DATE

12. MSFC APPROVAL:

Joseph E. Fisher Chief, Saturn I/IB Test Office	Dec 23 '65 DATE
D. A. Grau Manager, Saturn I/IB Program	29 Dec 65 DATE

13. MAT APPROVAL ☒ **DISAPPROVAL** ☐

Milton Silveg Director, Apollo Test	1-28-66 DATE
	DATE

14. REMARKS:

DEVIATION APPROVAL REQUEST - Number 6

Block 10. REASON FOR REQUEST (continued):

2. Present program planning requires completion of reliability assessment prior to flight of the first manned stage rather than manufacturing checkout of the first manned stage. Funding and schedule problems preclude completion prior to manufacturing checkout.

1. NASA - MSFC DEVIATION APPROVAL REQUEST - APOLLO TEST REQUIREMENTS

2. URGENT: YES ☐ NO ☐	3. NUMBER: SHEET 1 OF 1	4. REQUEST NO. 2
5. ATR PARAGRAPH REFERENCE: 3.5.3.2	6. TITLE: System Compatibility Tests, Requirements	7. STAGE OR HARDWARE AFFECTED: All

8. SPECIFIED REQUIREMENTS:

"3.5.3.2 REQUIREMENTS

As a minimum, systems compatibility tests shall provide reasonable assurance that stages, modules, launch vehicle, and spacecraft (for the specific configuration to be flown) are physically, functionally and operationally compatible prior to shipment of the first flight stages and modules to the test site."

9. DESCRIPTION OF DEVIATION:

Due to excessive cost schedule pressure and unavailability of hardware this requirement is not being met using complete flight stages and operational GSE. However, a plan has been developed which substantially complies with this requirement.

10. REASON FOR REQUEST: System compatibility data at the stage and vehicle level is being obtained from hardware provisioned for other phases of testing, for example: The MSFC Breadboard facility, the facility checkout vehicle at KSC, the Dynamic Test Vehicle and for the S-IVB the EDSIL facility at the Douglas plant. We anticipate that this approach will satisfy all form and fit requirements and the majority of the functional requirements. These tests will remain under continued surveillance by the Saturn V Test Office to insure that program objectives are being satisfactorily met.

11. CONCURRENCE

S-IC Manager	24 July 65 DATE
S-II Manager	28 July 65 DATE
S-IVB Manager	7/19/65 DATE
IU Manager	7/16/65 DATE
	DATE

12. MSFC APPROVAL:

	DATE
Chief, Sat. V Test Office	7/30/65 DATE

13 MAT APPROVAL ☒ DISAPPROVAL ☐

Director, Apollo Test	11/19/65 DATE
	DATE

14 REMARKS

NASA - MSFC DEVIATION APPROVAL REQUEST - APOLLO TEST REQUIREMENTS

2. URGENT: YES ☐ NO ☐	3. NUMBER: SHEET 1 OF 1	4. REQUEST NO. 3
5. ATR PARAGRAPH REFERENCE: 3.5.4.2.b	6. TITLE: Structural Tests, Requirements	7. STAGE OR HARDWARE AFFECTED: S-IC

8. SPECIFIED REQUIREMENTS:

"3.5.4.2.b REQUIREMENTS

As a prerequisite, tests of structural details and component structures should have been completed and evaluated."

9. DESCRIPTION OF DEVIATION:

Structural tests for components and major structures are being accomplished in parallel.

10. REASON FOR REQUEST: This approach is being used to enable the structures test program to reach maturity within the limits of the present Apollo Program schedule. A minimum of 3 years schedule slide and proportionate costs would be needed to conduct these tests in series as required.

11. CONCURRENCE

S-IC Manager	28 Jan 65 DATE
	DATE
	DATE
	DATE
	DATE

12. MSFC APPROVAL:

	DATE
Chief, Sat. V Test Office	1/30/65 DATE

13 MAT APPROVAL ☒ DISAPPROVAL ☐

Director, Apollo Test	11-19-65 DATE
	DATE

14 REMARKS

1. NASA - MSFC DEVIATION APPROVAL REQUEST - APOLLO TEST REQUIREMENTS

2. URGENT: YES ☐ NO ☐	3. NUMBER: SHEET 1 OF 1	4. REQUEST NO. 4

5. ATR PARAGRAPH REFERENCE: 3.6.2.a	6. TITLE: Ground Qualification Tests, Requirements	7. STAGE OR HARDWARE AFFECTED: S-IC, S-IVB

8. SPECIFIED REQUIREMENTS:

Ground qualification tests shall be completed prior to manufacturing checkout of the first flight stage.

9. DESCRIPTION OF DEVIATION:

Ground qualification tests shall be * completed prior to the first flight.

*First flight is based on MA-2 Schedule

10. REASON FOR REQUEST: The overall plan for Saturn V development was conceived and to a great extent implemented prior to the issuance of the ATR. Significant changes to the established sequence or pace are not feasible at this time since they cannot be implemented without adverse effect on the schedule even with expenditure of additional resources. A best effort will be made to comply with the ATR in this instance, however, total compliance cannot be achieved without major impact.

11. CONCURRENCE

S-IC Manager	28 Jul 65 DATE
S-IVB Manager	7/27/65 DATE
	DATE
	DATE
	DATE

12. MSFC APPROVAL

Chief, Sat. V R&Q Office	29 Jul 1965 DATE
Chief, Sat. V Test Office	7/30/65 DATE

13 MAT APPROVAL ☐ DISAPPROVAL ☐

Director, Apollo Test	11-19-65 DATE
See Item 14	DATE

14 REMARKS Approved on the basis that the description of deviation is changed from: "Ground qualification tests shall be completed prior to the first flight" to "Ground qualification tests shall be completed prior to the delivery of the first flight stage to KSC."

1. NASA - MSFC DEVIATION APPROVAL REQUEST - APOLLO TEST REQUIREMENTS

2. URGENT: YES ☐ NO ☐	3. NUMBER: SHEET 1 OF 1	4. REQUEST NO. 6
5. ATR PARAGRAPH REFERENCE: Table 3-3	6. TITLE: Reliability Demonstration Tests	7. STAGE OR HARDWARE AFFECTED: All

8. SPECIFIED REQUIREMENTS:

Reliability demonstration tests for flight type hardware shall be completed prior to the manufacturing checkout of the first manned flight stage.

9. DESCRIPTION OF DEVIATION:

Reliability demonstration tests for flight type hardware shall be completed prior to the launch of SA-503.*

*Based on MA-2 Schedule

10. REASON FOR REQUEST: Program planning and facility acquisition in support of reliability demonstration tests have been based on the SA-507 mission, previously designated to be the first manned flight. Reliability testing cannot be accelerated sufficiently to keep pace with the decision to move the manned mission up to SA-503. To meet the same milestone for that flight would require shortening the reliability test program approximately sixteen months, however, current estimates indicate not more than a four month reduction can be expected. This is reflected in Block 9.

11. CONCURRENCE

S-IC Manager	28 July 65 DATE
S-II Manager	28 July 65 DATE
S-IVB Manager	11/23/65 DATE
IU Manager	7/16/65 DATE
	DATE

12. MSFC APPROVAL:

Chief, Sat. V R&Q Office	Jul 28 1965 DATE
Chief, Sat. V Test Office	7/30/65 DATE

13 MAT APPROVAL ☐ DISAPPROVAL ☐

Director, Apollo Test	11-19-65 DATE
See Item 14	DATE

14 REMARKS Approved on the basis that the description of deviation is changed from: "Reliability demonstration tests for flight type hardware shall be completed prior to launch of SA-503." to "Reliability demonstration tests for flight type hardware shall be completed prior to delivery of SA-503 to KSC."

GPO 904-336

CHANGE APPROVAL PROCEDURE

CENTER REQUEST FOR CHANGE TO THE ATR

THE CENTER WILL:

A. SUBMIT THE REQUEST FOR A CHANGE TO THE ATR TO DIRECTOR, APOLLO TEST, CODE MAT, WITH A JUSTIFICATION FOR THE CHANGE.

B. SEND COPIES OF THE REQUEST TO OTHER CENTERS AND COMMUNICATE DIRECTLY WITH THOSE CONCERNED.

APOLLO PROGRAM OFFICE ACTIONS ON CHANGES

DIRECTOR, APOLLO TEST, CODE MAT, WILL:

FOR CENTER INITIATED REQUEST FOR CHANGE:
REVIEW REQUEST AND RECOMMENDATIONS RECEIVED FROM THE CENTERS AND MAKE RECOMMENDATIONS TO THE DIRECTOR, APOLLO PROGRAM, CODE MA WHO WILL APPROVE OR DISAPPROVE THE REQUEST AND INFORM THE CENTERS CONCERNED

FOR MSF INITIATED CHANGE:

REQUEST COMMENTS AND RECOMMENDATIONS FROM THE CENTERS CONCERNED WITHIN 20 WORKING DAYS AND INFORM THE CENTERS OF APPROVAL OR DISAPPROVAL.

REVISION OF ATR

DIRECTOR, APOLLO TEST, CODE MAT, WILL REVISE THE ATR AT APPROPRIATE INTERVALS TO INCLUDE APPROVED CHANGES AND SEND COPIES TO THE CENTERS.

COMMENTS AND RECOMMENDATIONS

ALL CENTERS CONCERNED WILL:

A. SUBMIT COMMENTS AND RECOMMENDATIONS TO DIRECTOR, APOLLO TEST, CODE MAT, WITHIN 20 WORKING DAYS.

B. COMMUNICATE DIRECTLY WITH THE REQUESTING CENTER AND OTHER CENTERS CONCERNED.

DEVIATION APPROVAL PROCEDURE

CENTER REQUEST FOR DEVIATION TO THE ATR*

THE CENTER WILL:

A. SUBMIT THE REQUEST TO DIRECTOR, APOLLO TEST, CODE MAT, INDICATING URGENCY AND JUSTIFICATION CONTAINING AT LEAST THE FOLLOWING:

1. THE SPECIFIC PROGRAM LIMITATIONS PREVENTING FULFILLMENT OF REQUIREMENT.
2. ADDITIONAL PROGRAM RESOURCES OR TIME NEEDED TO COMPLY WITH THE REQUIREMENTS.
3. RECOMMENDED ALTERNATE COURSES OF ACTION WHERE APPLICABLE, INCLUDING PROGRAM RESOURCES, SCHEDULES, ETC.
4. IMPACT ON PROBABILITY OF CREW SAFETY AND MISSION SUCCESS.

B. SEND COPIES OF REQUEST TO OTHER CENTERS AND COMMUNICATE DIRECTLY WITH THOSE CONCERNED.

COMMENTS AND RECOMMENDATIONS

OTHER CENTERS CONCERNED WILL:

A. SUBMIT COMMENTS AND RECOMMENDATIONS TO DIRECTOR, APOLLO TEST, CODE MAT, AS SOON AS POSSIBLE FOR URGENT ACTIONS, BUT WITHIN 10 WORKING DAYS FOR ALL ACTIONS.

B. COMMUNICATE DIRECTLY WITH THE REQUESTING CENTER AND OTHER CENTERS CONCERNED.

APOLLO PROGRAM OFFICE ACTIONS ON DEVIATIONS

DIRECTOR, APOLLO TEST, CODE MAT, WILL:

REVIEW REQUEST AND RECOMMENDATIONS RECEIVED FROM OTHER CENTERS AND MAKE RECOMMENDATIONS TO THE DIRECTOR, APOLLO PROGRAM, CODE MA WHO WILL APPROVE OR DISAPPROVE THE REQUEST AND INFORM THE CENTERS CONCERNED.

REVISION OF ATR

DIRECTOR, APOLLO TEST, CODE MAT, WILL REVISE THE ATR AT APPROPRIATE INTERVALS TO INCLUDE APPROVED DEVIATIONS NOT OF A TEMPORARY NATURE AND SEND COPIES TO THE CENTERS.

* CENTERS WILL NOT WAIT FOR APPROVAL OR DISAPPROVAL OF THE REQUEST FOR DEVIATION IF WAITING WILL CAUSE UNDUE PROGRAM DELAY OR INCREASED COSTS.

WHERE THE REQUIREMENTS FOR CERTIFICATION OF FLIGHT WORTHINESS CANNOT BE MET WITHOUT DELAY IN SHIPMENT OF THE HARDWARE, THE CENTER PROGRAM MANAGER WILL CONFER WITH THE DIRECTOR, APOLLO PROGRAM, CODE MA, AND THE DECISION AGREED UPON WILL BE DOCUMENTED AND USED IN LIEU OF A DEVIATION APPROVAL.

APPENDIX B

DEFINITIONS

This appendix contains the definitions of many of the terms used in the text of the ATR. Wherever possible definitions agree with NASA SP-6001, Apollo Terminology.

Acceptance Test

Test to determine conformance to design or specifications as a basis for acceptance. When specially designed they may apply to parts, equipments or systems.

All-Systems Test

A test performed on stages and modules to demonstrate the capability of each subsystem to perform its function when exposed to the full rigors of mission environments, and to demonstrate that the subsystems are physically and functionally compatible. This test may be a combination of development test and qualification test.

Ambient Condition

Environmental conditions such as pressure, temperature, etc., which are normal for the location under discussion.

Apollo

The NASA program whose immediate goal is to land men on the lunar surface and return them safely to earth.

Assembly

A number of parts or subassemblies or any combination thereof joined together to perform a specific function.

Battleship Test

Static test program utilizing a partially or completely overdesigned nonflight vehicle to provide performance data on original design and design changes.

Boilerplate

A piece of test hardware, generally non-functioning, which structurally simulates weight, center of gravity, and aerodynamic configuration. It may incorporate interim structural shells or dummy structures. Internal systems may be inert or contain selected functional subsystems

for obtaining flight data for development purposes. A functional mock-up modeled to simulate a subsystem or system for the purpose of evaluating the performance.

Change

A modification to the ATR published as a supplement to the current issue.

Checkout

A test or procedure for determining whether a person or device is capable of performing a required operation or function. When used in connection with equipment, a checkout usually consists of the application of a series of operational and calibrational tests in a certain sequence, with a requirement that the response of the device to each of these tests be within a predetermined tolerance. For personnel, the term checkout is sometimes used in the sense of a briefing or explanation to the person involved, rather than a test of that person's capability.

Class of Hardware

All hardware produced to a specific design for a specific application.

Cognizant NASA Installation

The organizational unit of NASA which has technical direction or managerial responsibility for specified work.

Component

An article which is normally a combination of parts, sub-assemblies, or assemblies and is a self-contained element within a complete operating equipment.

Crew Safety

Crew safety is defined as the unimpared well being of the astronauts and will be demonstrated by the return and recovery of all crew members with no more than transient mental or physical injury and no loss of physiological function which would adversely affect performance of astronaut duties.

Criticality

Assignment of relative importance to hardware or systems.

Design Specification

A document prescribing criteria to be satisfied in designing a particular piece part, component, assembly, subsystem, or system. Typical

criteria include performance requirements under specified environments, interface requirements, size, weight, ruggedness, derating factor, and apportioned reliability goal (with definition of failure.)

Development

Development tests are performed to assure the proper functioning of the components of the system. Specific test objectives include: determination of feasibility of design approach, evaluation of hardware performance under simulated or actual environmental conditions, and evaluation of hardware failure modes and safety factors.

Deviation

A specific authorization, granted before the fact, to depart from a particular requirement of specifications or related documents.

Documentation

Information that is generated to record data required for control of design, production, procurement, maintenance, and supply of material, e.g., drawings, specifications, handbooks, manuals, etc.

Dynamic Test

Ground test designed to determine the structural dynamic characteristics of stages or space vehicles (bending modes, structural feedback constants, damping constants, natural resonances, etc.) under simulated flight conditions. This test may be combination development test and qualification test.

Emergency Detection System

A space vehicle system that is designed to detect abnormal conditions which will endanger the astronauts.

Emergency Hardware

Those items of flight hardware which are utilized to detect emergency conditions, to execute emergency action, or to provide redundant modes of operation in case of failure of primary hardware.

Engineering Confidence

Confidence, in a design or product, which is based on engineering calculations and tests.

Environmental Test

Any production acceptance test (in-process test, manufacturing checkout, etc.) performed under environmental rigors other than ambient for the prime purpose of verifying the quality of flight hardware or ground equipment.

Failure

The inability of a system, subsystem, component, or part to perform its required function.

Failure Effect Analysis

Study of the potential failures which might occur in any part of a system to determine the probable effect on other parts of the system, crew safety and mission success.

Failure Mode

The physical description of the manner in which a failure occurs, and the operating condition of the equipment at the time of the failure.

Flight Development Test

To assure the proper functioning of the components of a system when exposed to actual operating conditions. Specific test objectives include: determination of feasibility of design approach, evaluation of hardware performance under actual environmental conditions, and evaluation of hardware failure modes and safety factors. The completion of the development phase of flight testing may involve the redesign, retesting and modification of drawings and specifications.

Flight Environment

The conditions to which items of hardware will be exposed during the flight mission profile. This consists of natural environments and induced environments (see Natural Environment and Physical Standards for the Apollo Program, SE015-001-1).

Flight Hardware

Hardware assigned for flight (see Apollo Flight Mission Assignments, SE010-000-1).

Flight Type Hardware

Hardware which is identical to flight hardware in design and fabrication and assigned for uses other than flight. Example: ground test.

Flight Verification Test - Unmanned

To demonstrate safe functioning and achievement of minimum performance requirements of the components of a vehicle or spacecraft system when exposed to unmanned operating conditions.

Flight Verification Test - Manned

To demonstrate the operational suitability of equipment under the actual conditions it will encounter in fulfillment of a manned mission.

Functional Test

A test performed to demonstrate that the operation of the item tested is as specified (required).

Generation Level

The level of assembly of hardware. The levels are called piece part, component, assembly, subsystem, stage or module, space vehicle or GSE major system.

Ground Qualification Test

The Ground Qualification Program test objective is to verify that the space vehicles and associated ground support equipment meet design specification requirements necessary to assure operational suitability at anticipated environments for their use cycles.

Ground Support Equipment (GSE) - Active

That equipment which interfaces with or is part of the vehicle system and which actively participates in the system operation and/or test.

Ground Support Equipment (GSE) - Passive

That equipment which interfaces with the vehicle but does not actively participate in, or feed back to, the vehicle system operation and/or test.

GSE Major End Item

A functional unit of ground support equipment which is complete within itself and which performs an essential ground support function during flight operations. Examples: hydraulic pumping unit, fuel and oxidiser fill and drain units, and ground air conditioning unit.

GSE Major System

A complex, functional assemblage of ground support equipment, including inter-unit cabling, which performs an essential ground support function during flight operations. This includes such items as the pre-launch automatic checkout equipment, guidance and trajectory computer system, life support system checkout equipment, launch control system, etc.

GSE - Operational

Ground support equipment which will be used to support space vehicle flights.

GSE Operational Type

Ground support equipment which is identical to GSE operational in design and fabrication. It is utilized for qualification tests only.

Hardware Criticality Category

A class or division of hardware with the same criticality assignment. These categories are utilized for the purpose of establishing test requirements. (see: table 3-1, Hardware Criticality Categories for Flight Hardware; and table 3-2, Hardware Criticality Categories for Ground Support Equipment.)

Induced Environment

The state or conditions which exist due to the interaction of the natural environment and the test subject.

In-Process Tests

All production line tests performed at intermediate points between receiving tests and start of final manufacturing checkout. These are acceptance tests.

Instrument Unit

In the Saturn series, an adapter or module between the launch vehicle and spacecraft. It houses the guidance systems, telemetry equipment, power supply, RF systems and in-flight instrument unit air conditioning equipment.

Interface

The point or area where a relationship exists between two or more parts, systems, programs, persons, or procedures wherein physical and functional compatibility is required.

Launch Vehicle

The part of the space vehicle which furnishes the propulsion and guidance during the initial part of the trajectory to provide the prescribed velocity, position, and attitude required for injection into the desired trajectory. Launch vehicles are commonly called boosters and consist of one or more propulsive stages.

Maintenance

The function of retaining material in or restoring it to a serviceable condition.

Manufacturing Checkout

The final acceptance test or series of tests performed after final assembly at a manufacturer's plant. Successful completion of manufacturing checkout is a prerequisite to assembly into the next higher hardware generation level at another contractor's plant or NASA installation and for shipment to a static firing site or installation site.

Mission

A definite assignment calling for performance during a space flight or group of space flights. Examples:

(a) Apollo mission - the placing of a man on the moon and his safe return to earth.

(b) Flight mission (Space Vehicle No. xx-x).

Primary: the verification of the launch vehicle.
Secondary: the evaluation of the performance of the service module reaction control system.

(c) Component mission - the task assigned to a specific component during the fulfillment of a flight mission or missions.

Module

A combination of structures, equipments, and systems common to a single mounting that provide a mission function or functions, i.e., instrument unit, command module, service module, lunar excursion module, and space suit.

Non-Destructive Testing

Testing of a nature which does not impair the usability of the item.

Operational

Of or pertaining to operations (activities) associated with the launch, flight, and recovery of flight vehicle.

Operational Status

The status of an item of flight hardware which has completed flight qualification and is ready to perform flight missions other than flight testing of the item itself.

Piece Part

An article that is not functionally useful by itself, but is an element of an item in a higher generation level. It is of such construction that further dissassembly is not practical.

Pre-Launch Checkout

Checkout of missile and ground equipment to determine readiness to launch may include a countdown and a flight readiness firing with all launch complex equipment operating, but not including actual launching of the vehicle.

Primary Hardware

Those items of flight hardware which are normally utilized and are essential to the proper and continuous operation of spacecraft and launch vehicle during a flight mission.

Production Hardware

Flight hardware, flight type hardware, GSE operational equipment, or GSE operational type equipment produced in accordance with a formalized design which has been established as suitable for use in flight operations by development tests.

Production Tests

Functional and/or environmental acceptance tests conducted on fabricated or procured hardware prior to, during, and/or at the completion of assembly or manufacture for the purpose of determining whether the performance, tolerances, and quality are within specified limits. These tests include in-process tests and manufacturing checkout.

Qualification

The successful completion of qualification tests.

Quality Defect

Nonconformance with drawings and specifications due to workmanship or control procedures.

Receiving Tests

Non-destructive, functional tests performed on piece parts, components, or assemblies when received at the assembly facility. This is an acceptance test.

Reliability

The probability that system, subsystem, component, or part will perform its required functions under defined conditions at a designated time and for a specified operating period.

Reliability Assessment

An analytical determination of numerical reliability of a system or portion thereof without actual demonstration testing. Such assessments usually employ mathematical modeling, use of available test results, and some use of estimated reliability figures.

Reliability Demonstration Test

A statistically designed test, with specified confidence level, to demonstrate that an item meets the established reliability requirements.

Revision

A complete reissue of the ATR, incorporating all approved outstanding changes at date of issue.

Safety Factor

The ratio of the load that would cause failure of a member or structure to the maximum load that is imposed upon it in service. It also may be used to represent the ratio of failure to service value of speed, deflection, voltage, temperature, or other stress-producing factors.

Sample Size

The number of units in a sample. Also used in the sense of the number of observations in a sample.

Screening Test

Test employing nondestructive environmental, electrical, or mechanical stresses to identify anomalous items.

Self Verification

Performance of internal checks by equipment upon itself to determine its readiness to perform specified functions.

Spacecraft

The vehicle required to perform the missions after injection into the mission trajectory and consists of the command module (includes LES), service module, lunar excursion module, and space suit.

Space Vehicle

The entire spaceborne element. It consists of the spacecraft and the launch vehicle.

Spare Part

A component of an item used to maintain or repair the item.

Stage

The independent propulsive sections of a launch vehicle which are progressively jettisoned during or immediately following the powered portions of flight.

Standard Hardware

Hardware of established design which has encountered extensive use.

Static Firing Test

A captive firing of a flight stage or module for the prime purpose of verifying integrated performance of the propulsion and control subsystems and for verifying the capability of the subsystems to function under environments generated by engine(s) operating under full thrust (or variable thrust, where applicable) conditions.

Structural Test

A development test and/or qualification test to determine the ability of structures to withstand predicted or measured static and dynamic forces to be encountered in assembly, storage, transportation, handling, and flight.

Subsystem

A major functional subassembly or grouping of items or equipment which is essential to operational completeness of a system.

System

Any combination of parts, assemblies and sets joined together to perform a specific operational function or functions.

Systems Compatibility Test

A test to determine the physical, functional and operational compatibility of stages, stage and IU, launch vehicle and spacecraft, modules, spacecraft and LES, space vehicle and ground support equipment and systems within the ground support equipment.

Test Anomaly

An unexplained event, result, or condition occurring in a test, either on the test specimen or test system, which in some way makes uncertain the result of the test or some attribute of the test specimen.

Time Critical Equipment

Equipment with a finite life which if not monitored, could result in a failure. Consideration shall be given to shelf life.

APPENDIX C

LIST OF ABBREVIATIONS AND CODES

ATR	Apollo Test Requirements
CM	Command Module
COFW	Certification of Flight Worthiness
CSM	Command Module - Service Module, combined configuration
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
IMCC	Integrated Mission Control Center
IU	Instrument Unit
KSC	Kennedy Space Center
LEM	Lunar Excursion Module
LES	Launch Escape System
M	Associate Administrator for Manned Space Flight
MA	Director, Apollo Program
MAT	Director, Apollo Test
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
RCS	Reaction Control System
SM	Service Module
WSMR	White Sands Missile Range

GPO 920-732